# THE INSTITUTION OF PRODUCTION ENGINEERS JOURNAL

AUGUST 1956

# THE INSTITUTION OF

# PRODUCTION ENGINEERS JOURNAL

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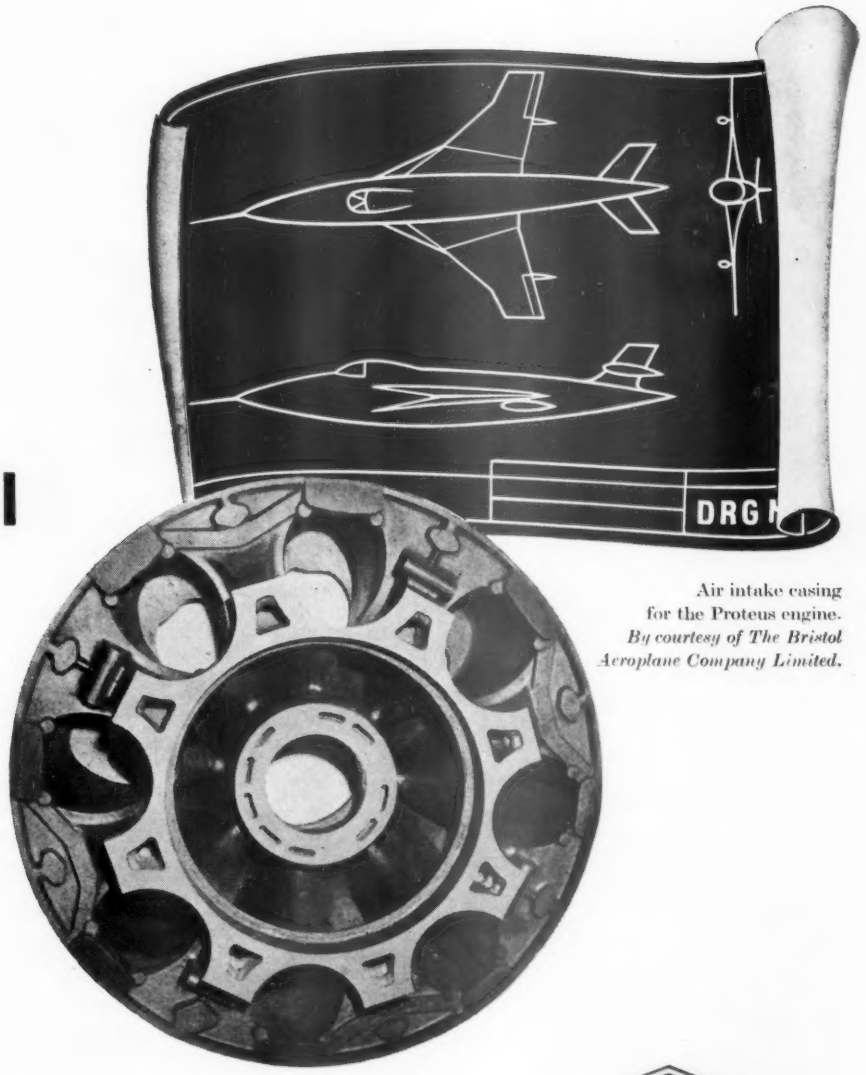


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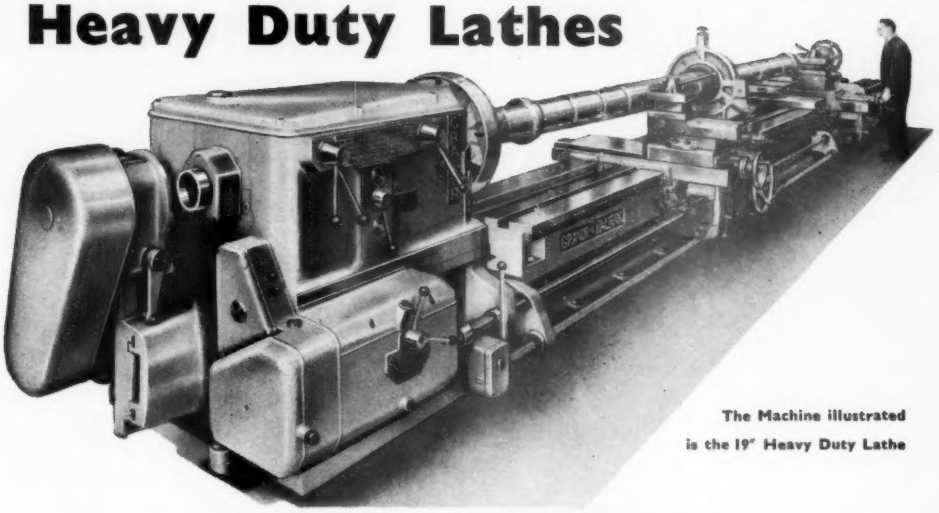

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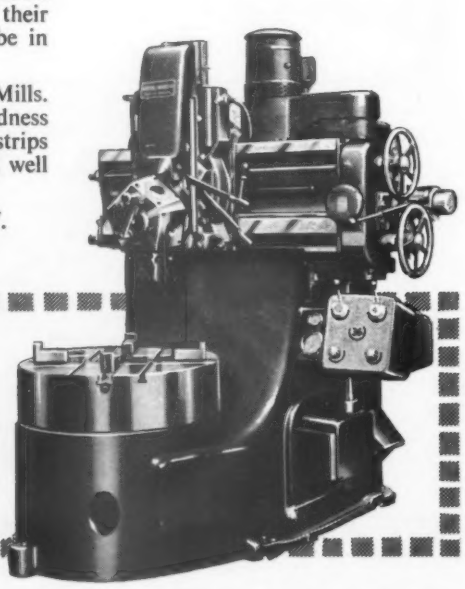

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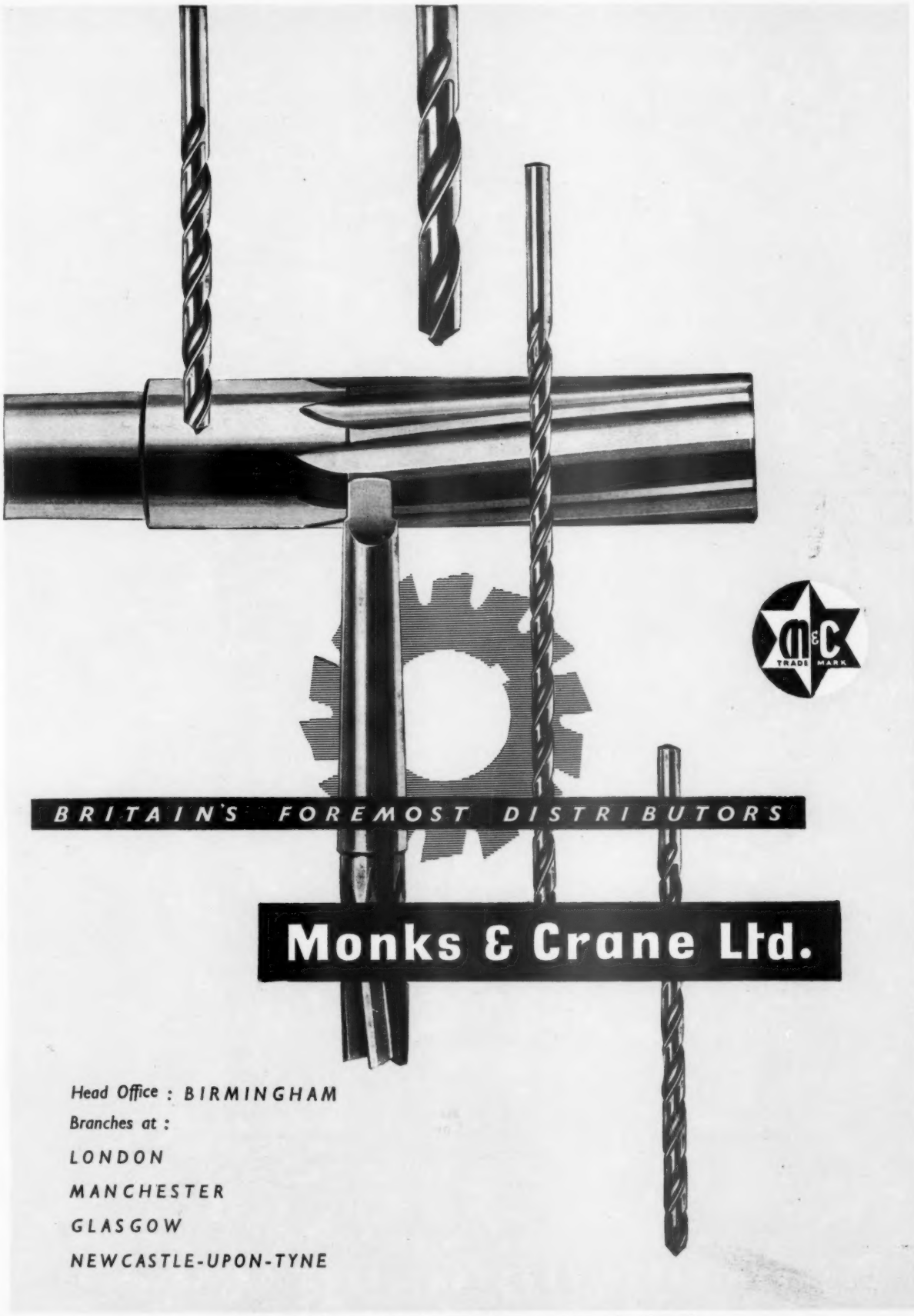
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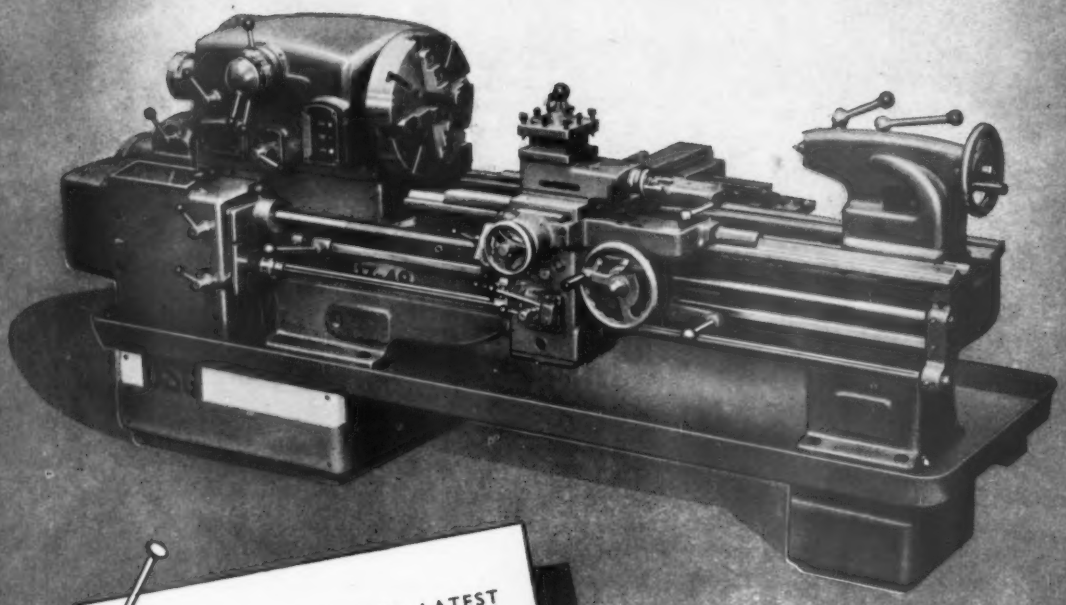

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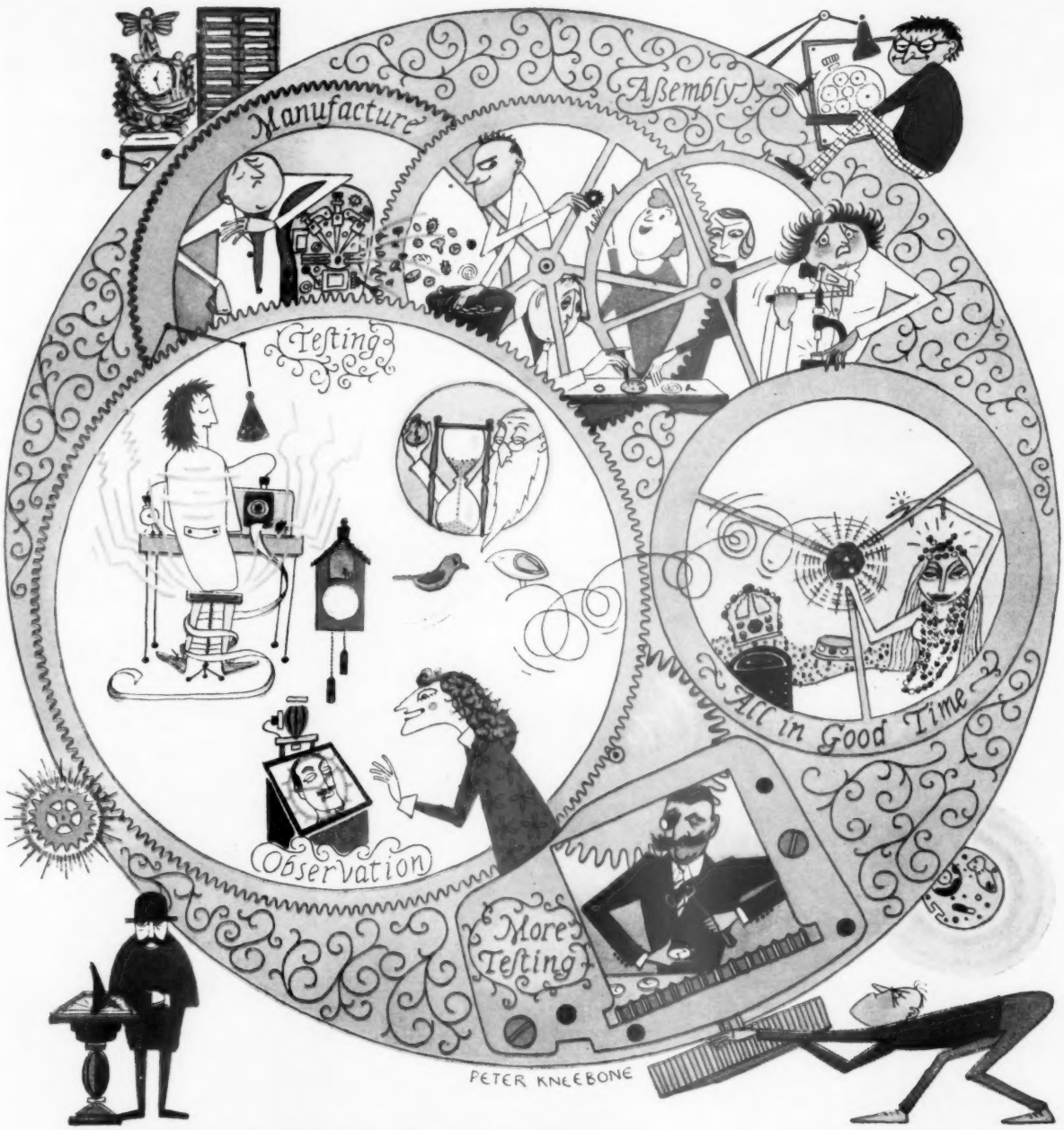


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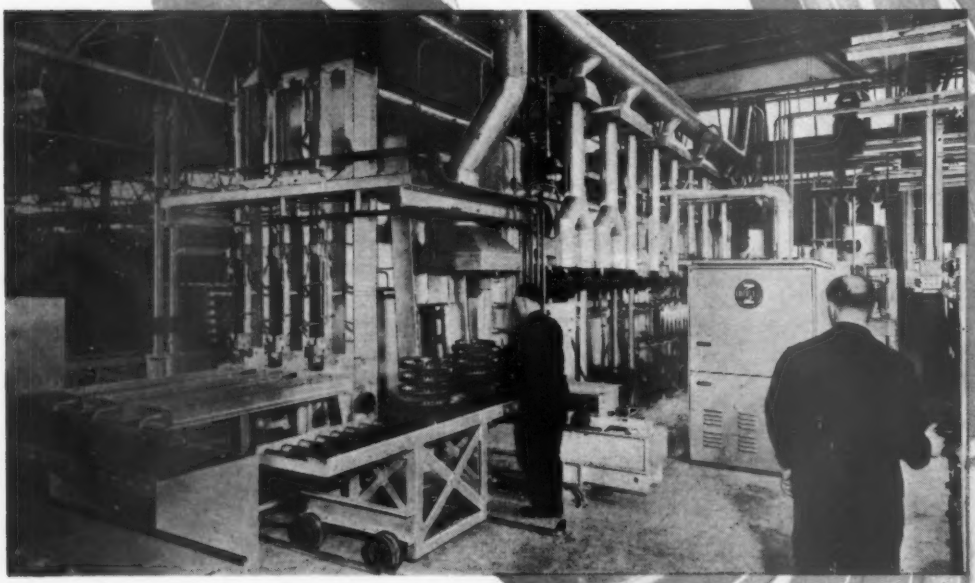

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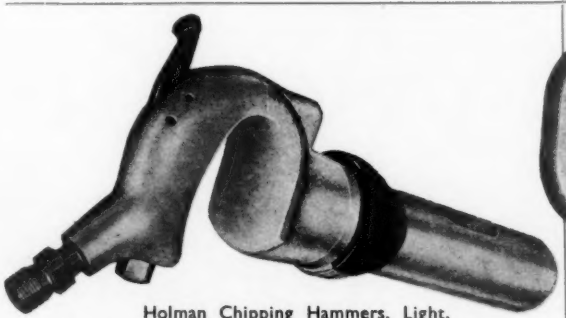

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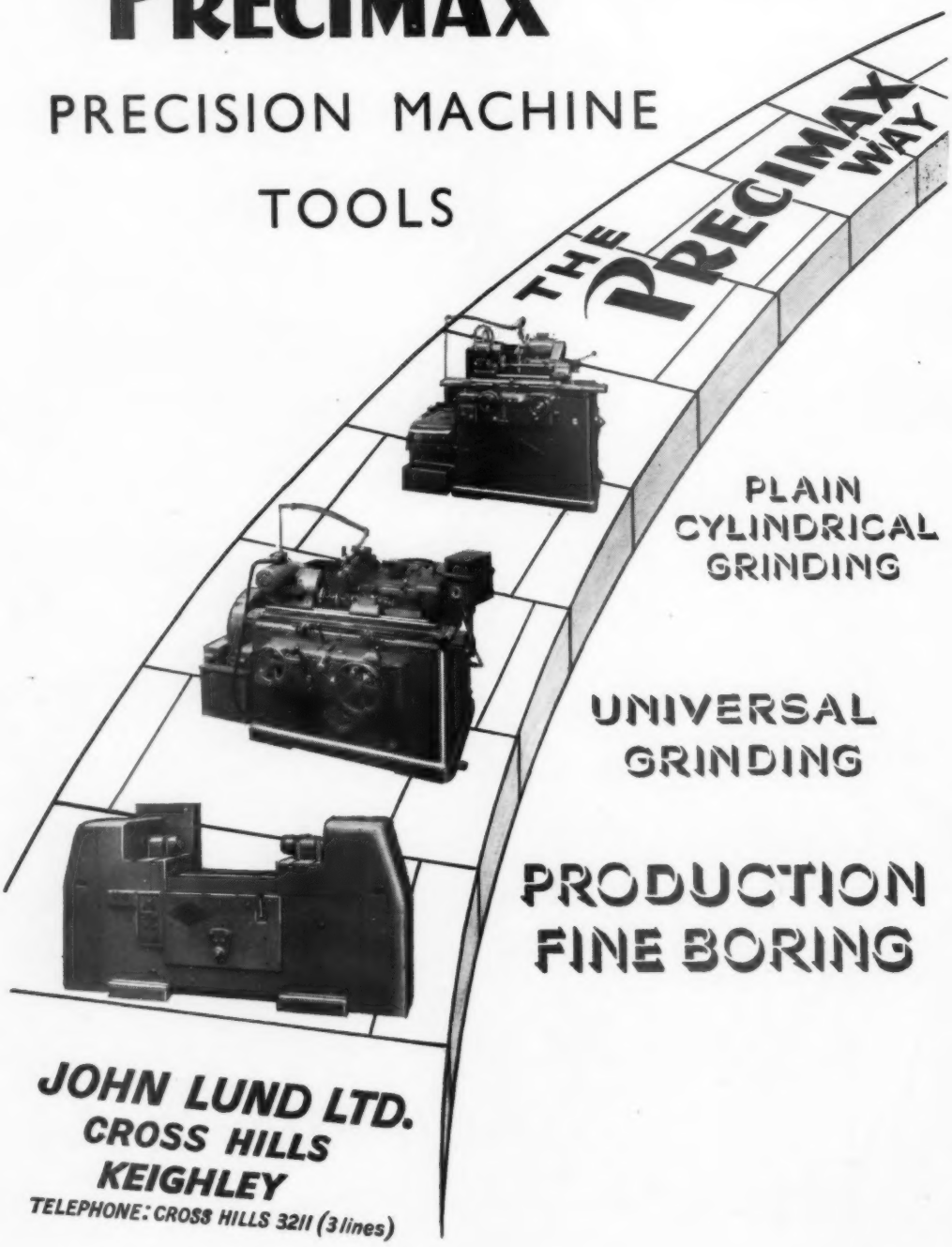


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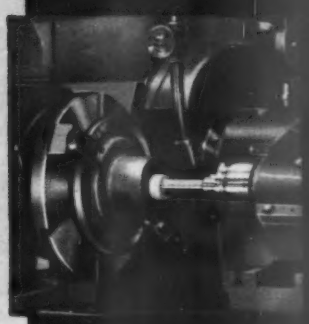
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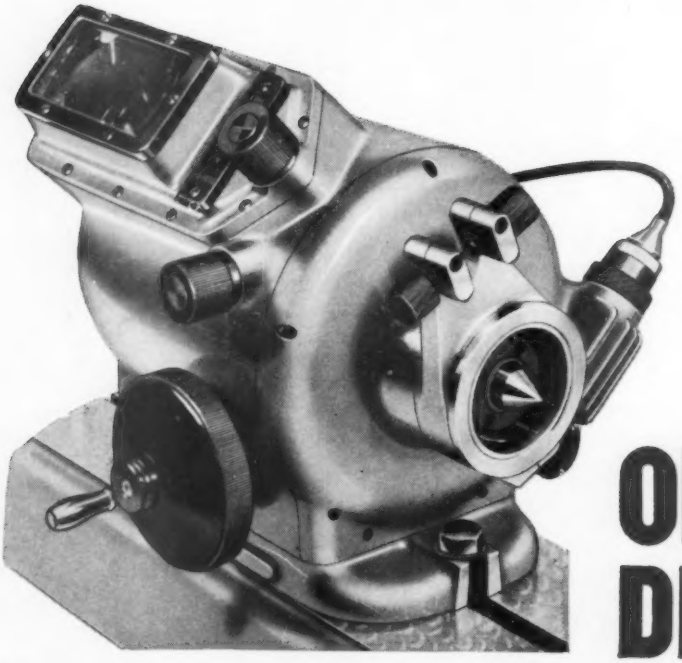

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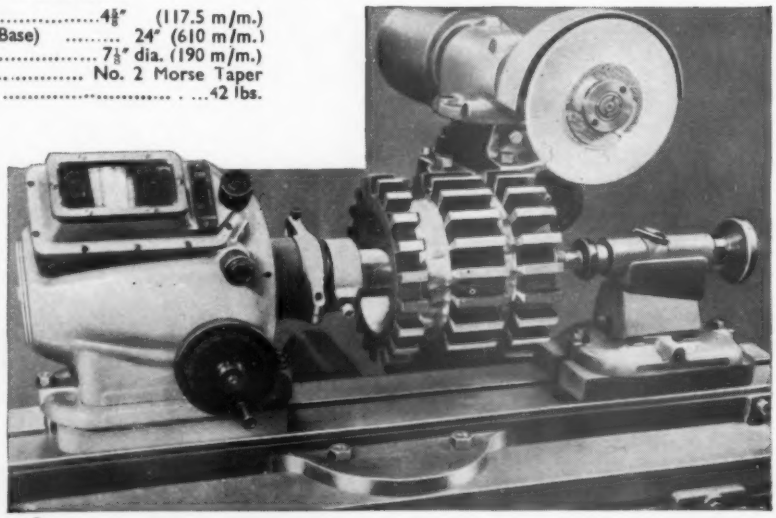

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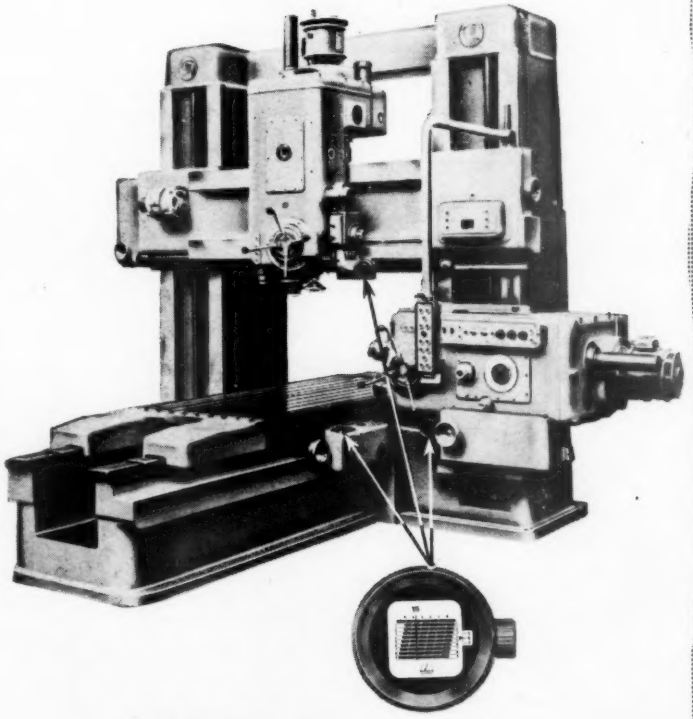

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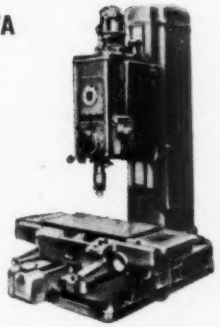

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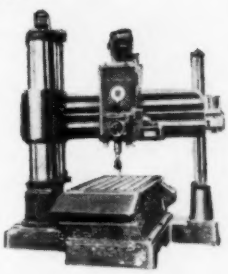

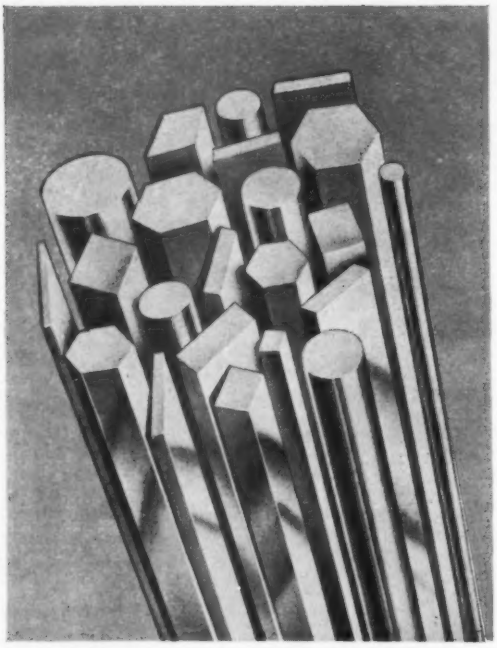

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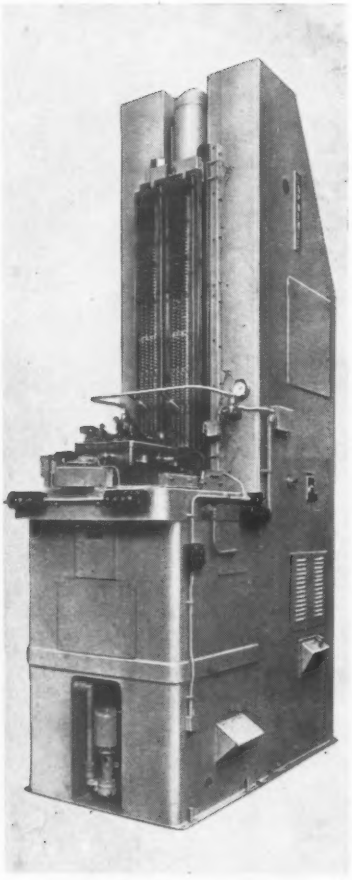

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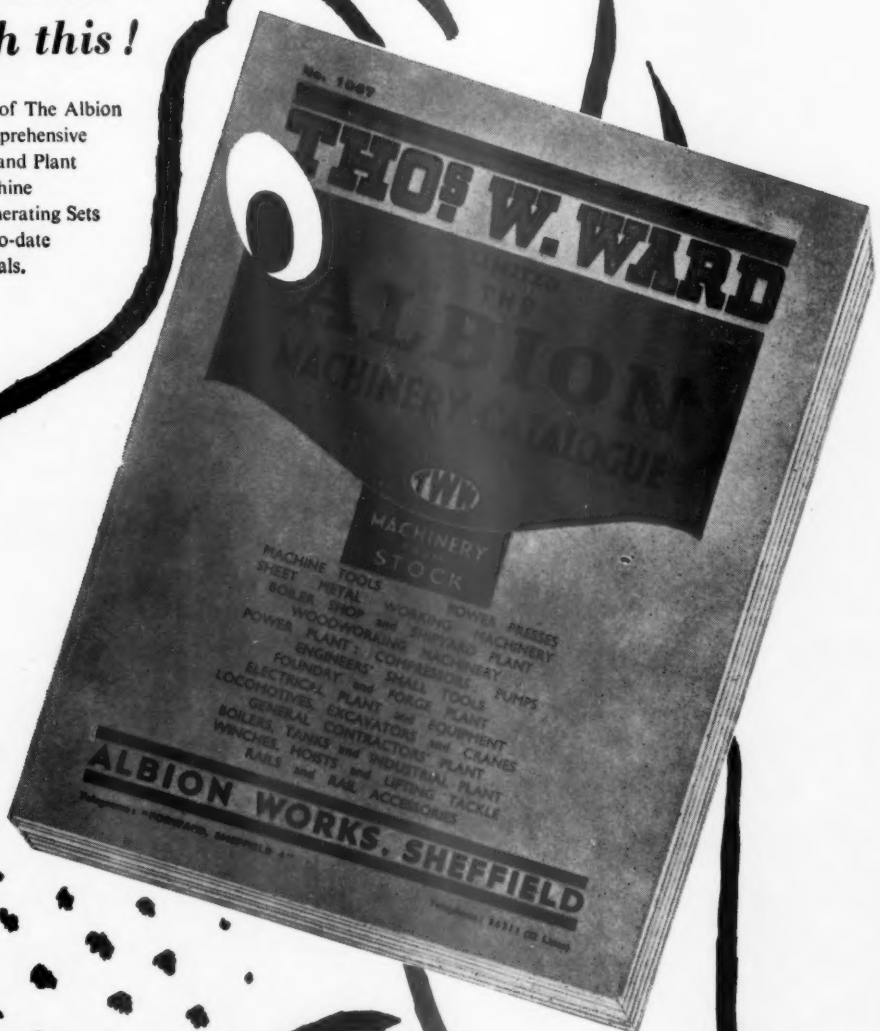


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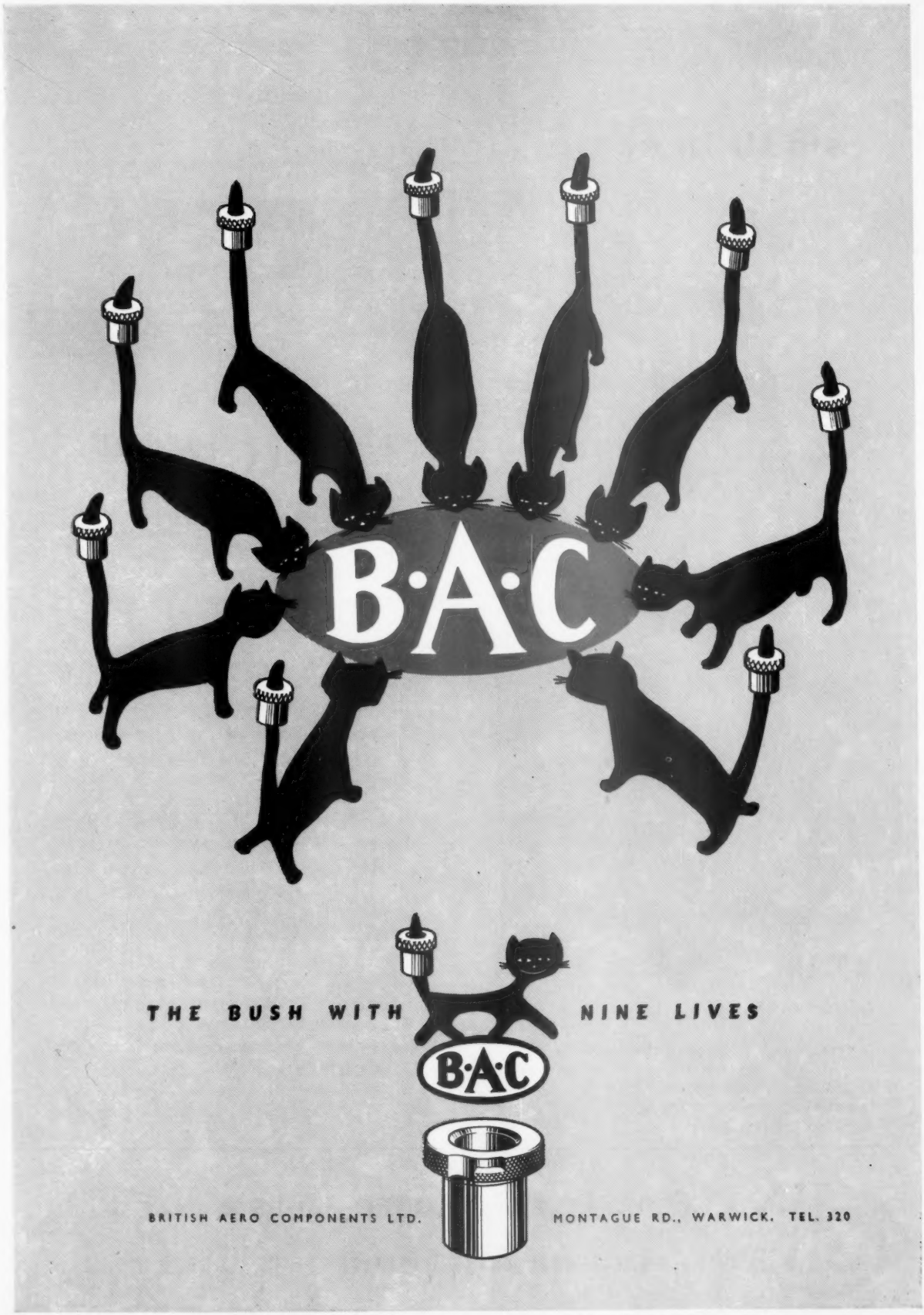
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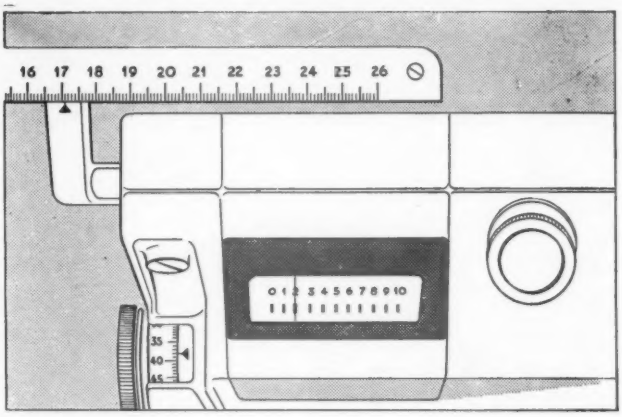
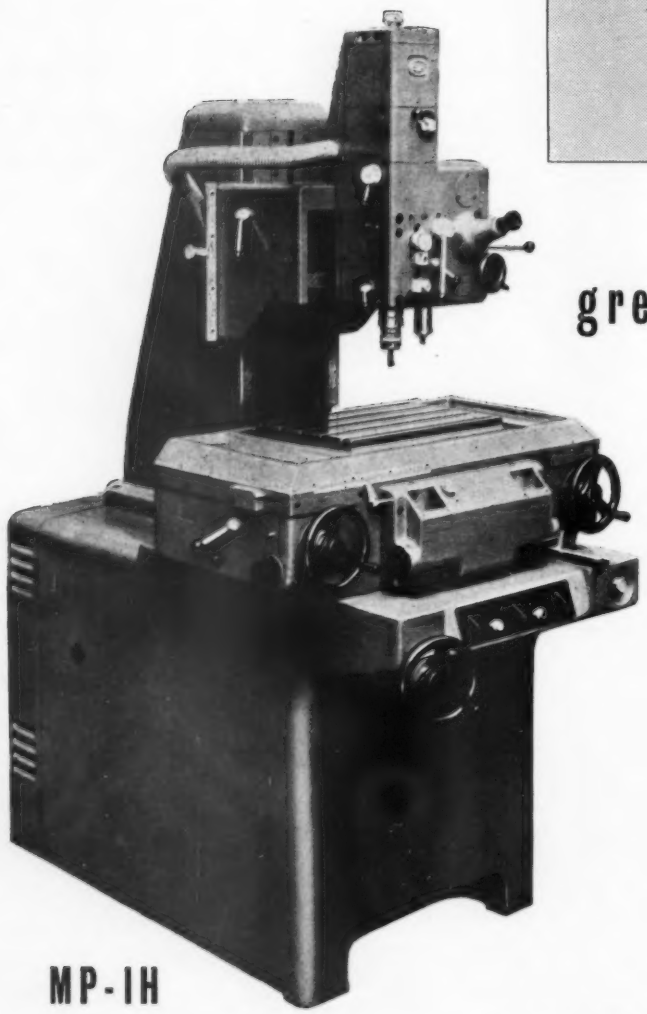


## great in performance

With a guaranteed accuracy of *0.00008 in.*, this jig-boring machine is capable of very high-precision work. *Built-in standard scales*, together with *built-in viewing screens*, enable this high standard of accuracy to be achieved. The three tools normally in constant use—the spindle, spotting tool and microscope—*are incorporated in the boring head*, thus permitting simultaneous observation of the work-piece and tool.

The spindle runs in high precision roller and ball bearings, and its rotation can be locked during tool changes. The work-table settings are effected on opaque screens eliminating parallax and glare.

### MP-IH

| | |
|---|---|
| Longitudinal travel of table | 8 in — 200 mm. |
| Transverse travel of table | 8 in. — 200 mm. |
| Distance from table top to spindle | min. 2 in. — 50 mm. |
| end (retracted) | max. 11¾ in. — 300 mm. |
| 7 spindle speeds — 430 — 640 — 860 — 1280 | |
| (for 60~) 1800 — 2560 — 3600 r.p.m. | |
| Maximum boring capacity | approx. 1 in. — 25 mm. |

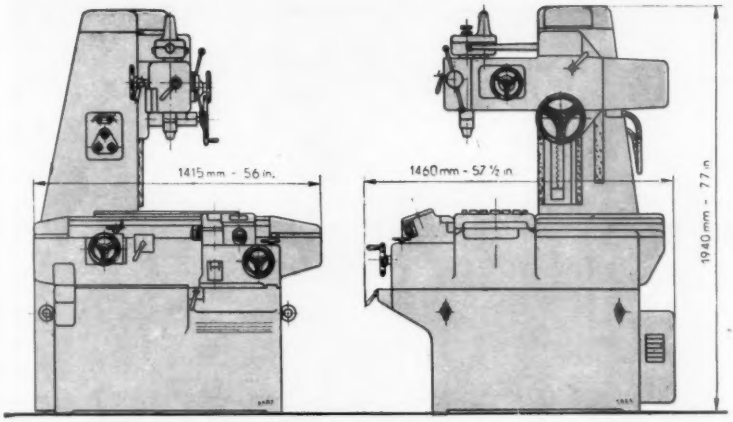
*The installation and service of this machine is carried out by the Area Engineers at Sogenique (Service) Ltd., under the GSIP guarantee.*

*For literature or further information please write or telephone Temple Bar 2126.*

GSIP

**Société Genevoise Ltd.**

5-6 BRETTENHAM HOUSE LANCASTER PLACE LONDON W.C.2.




# *Designed Precision . . .*

High precision jig-boring is achieved on this machine by a method of scale viewing normally used only on larger machines. Instead of the usual viewing microscopes, *projection screens* show highly magnified images of the standard scale graduation lines. This enables a high degree of accuracy to be obtained, together with exceptional ease of operation, and unproductive time is reduced to a minimum.

Further accuracy is guaranteed with the spindle head mounted on a non-dilatable frame, eliminating the effects of temperature variations on the slide.

*Permanence* of accuracy is ensured by the standard scales being totally enclosed and fully protected against dust and abrasives.

Finish milling is possible on this machine, using the hand-controls of the work-table.

**MP-2P**

*The installation and service of this machine is carried out by the Area Engineers of Sogenique (Service) Ltd., under the GSIP guarantee.*

*For literature or further information please write or telephone Temple Bar 2126.*

| | |
|---|---|
| Longitudinal travel of table ... ... ... ... ... | 16 in.—400 mm. |
| Transverse travel ,, ,, ... ... ... ... ... | 10 in.—250 mm. |
| Max. distance from table to spindle head ... | 19 in.—485 mm. |
| 8 spindle speeds 200 — 300 — 440 — 650 — 980 — 1400 — 2100 — 3000 | |
| Max. boring capacity ... ... ... ... ... | dia. 1¾ in.—40 mm. |
| GUARANTEED ACCURACY FOR ALL DISPLACEMENTS OF THE WORK-TABLE ... | *0.0001 in.—0.002 mm.* |

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**5-6 BRETTENHAM HOUSE LANCASTER PLACE LONDON W.C.2.**

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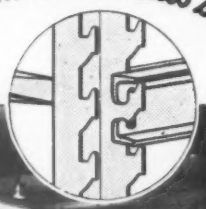

✓ *Eliminated 2/3 of former handlings*

These *Before* and *After* photos show how time in handling of materials was cut by two-thirds in this plant—and how storage capacity was increased by 300%. These racks can do the same for your plant. Investigate today!

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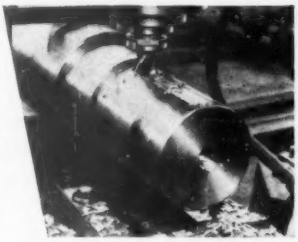
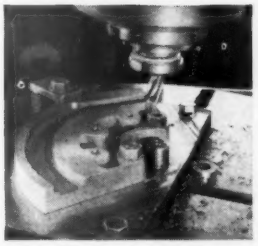
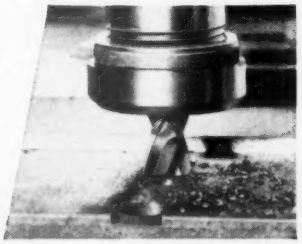


**Keyway Cutting,** $\frac{3}{8}$in. deep, $1\frac{3}{8}$in. wide, $8\frac{3}{4}$in. long, cut to depth at 260 r.p.m., 2 inches per minute feed in 35-ton Carbon Steel. This customer has reduced his machining time from 30 minutes to $4\frac{1}{2}$ minutes by using Autolock.



**Autolock** $\frac{1}{4}$**in. End Mill** making a finishing cut on a cam slot. The top rake and clearance angle on Clarkson Cutters ensure a fine finish for precision work of this nature. Medium 45-ton steel, 235 r.p.m. at approximately 2 inches per minute feed.



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# REMEMBER

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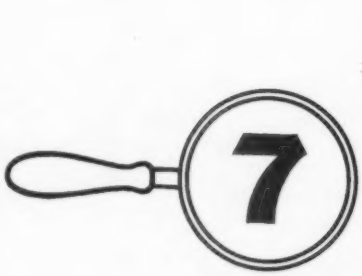


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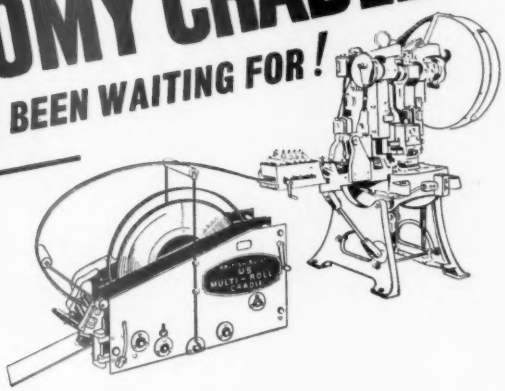


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Loop control roller.

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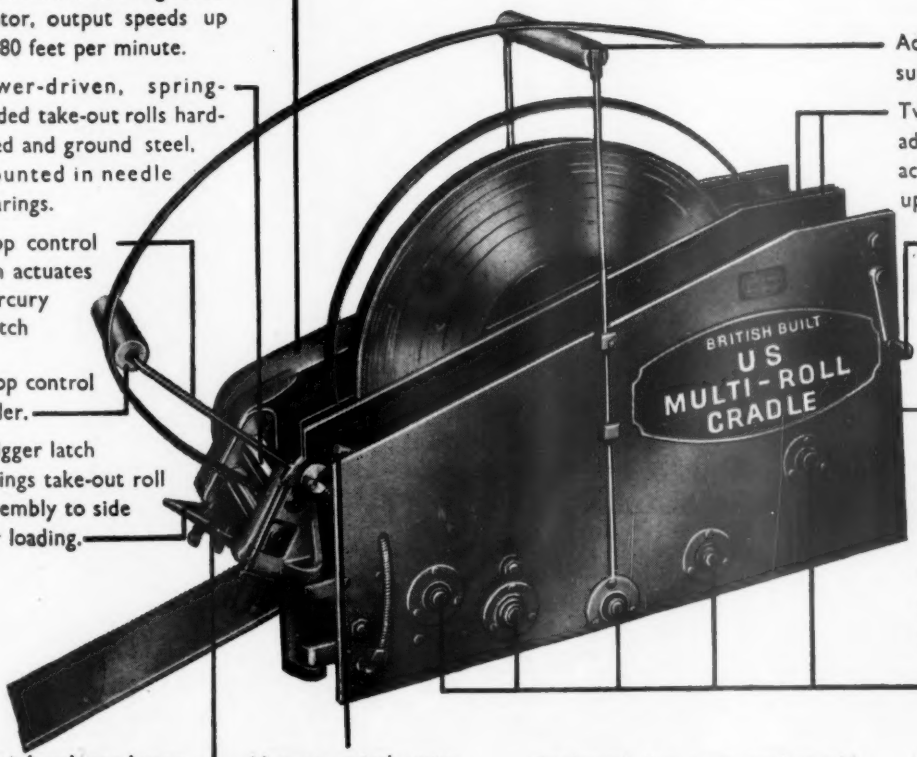


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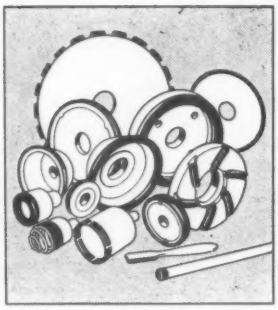
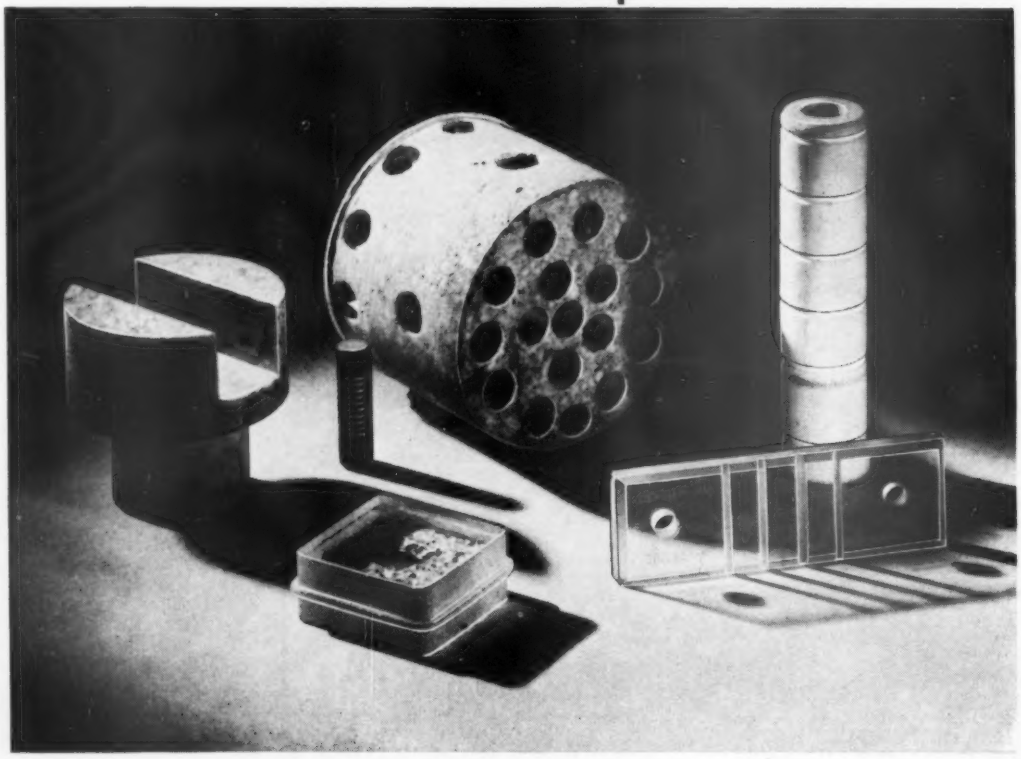


cut, drill or grind any hard material



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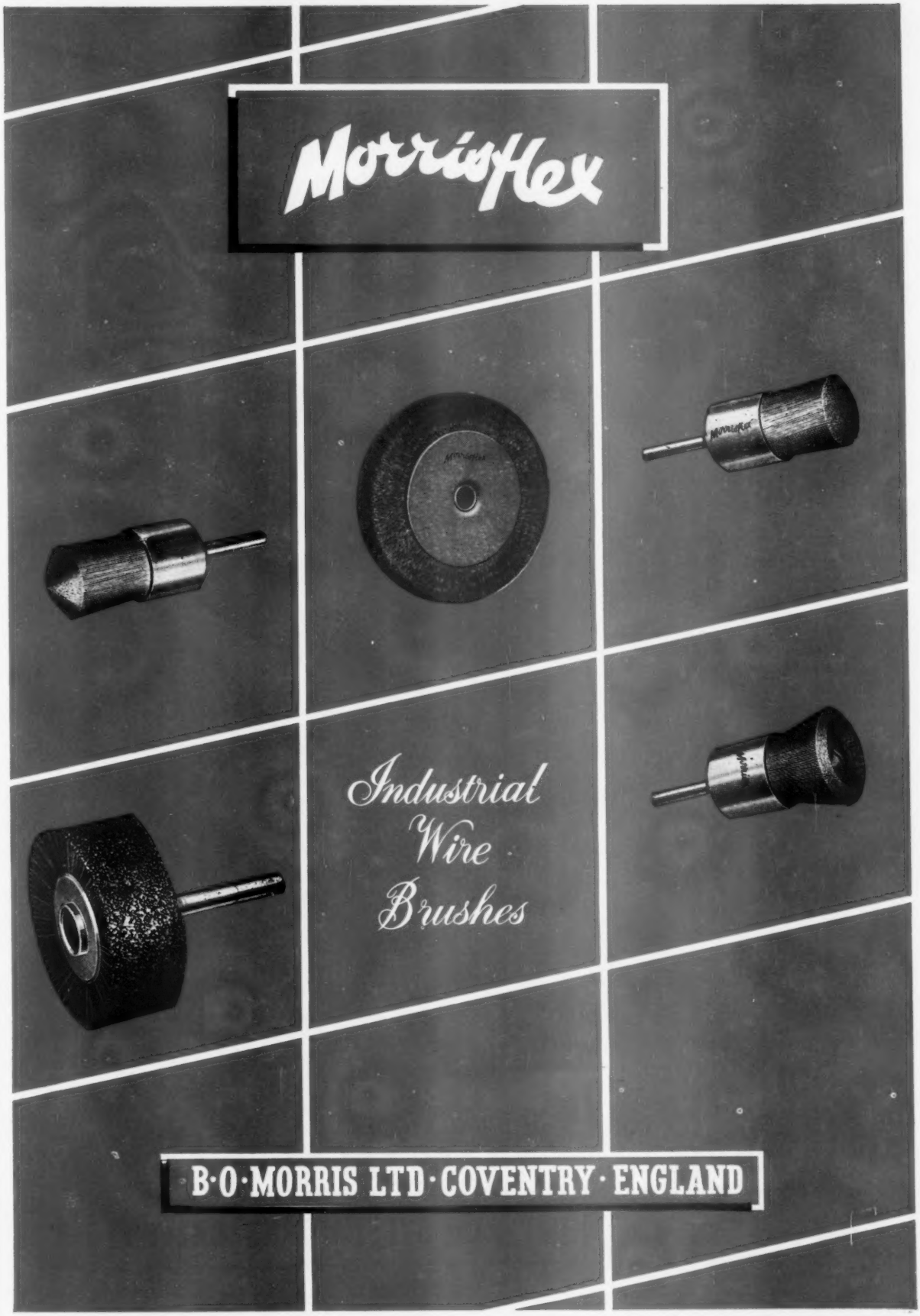
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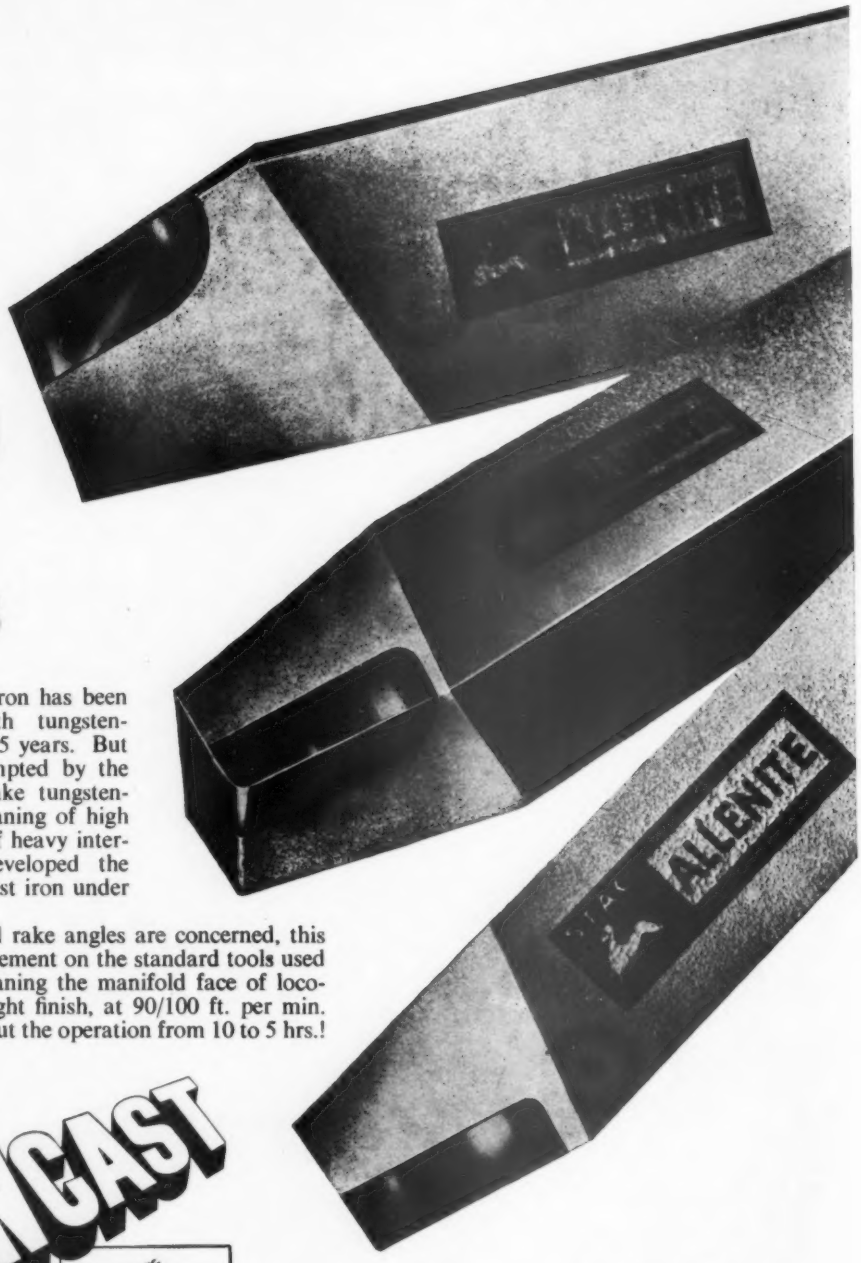


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The Institution of Production Engineers Journal
VOLUME 35 NO. 8 AUGUST, 1956

# Automation— A Curse or A Blessing?

by JAMES CRAWFORD,
General President, National Union of Boot and Shoe Operatives.

THE trade union movement will always be faced with the question of its attitude to mechanisation and new techniques and improved management methods. In arriving at a conclusion to any specific problem, consideration requires to be given to the past, as often the past enables us to determine our attitude in the future. There is no doubt that, on the whole, mechanisation, new technology, method study, etc., have been accepted without serious resistance over a very wide field of industry. The continuously rising national output could not have been achieved otherwise, as the optimum physical and mental effort, within certain limits, is a constant factor — not a variable one — and the rising spiral of production must be due, therefore, either to mechanisation, technology or better management methods in the main.

Mechanisation is not the problem child of today. The inventor of the wheel has never been acknowledged. There are no statues to his memory — yet mechanisation started there. The first steam pressure valve was made in 1680. The first mechanical flour mill was in operation in Philadelphia in 1784 — continuous production was made possible by powered conveyors. In 1801 Jacquard was using a punched card system in the loom that still bears his name. In 1834 the British Navy was manufacturing biscuits by a fully mechanised process. The assembly line was in use in 1869 in an American meat packing firm. Nobody doubts that these developments and their successors have benefited mankind, although we are aware that decisions were taken without regard to immediate effects on labour, and within modern times such decisions have led to strained relations between management and labour.

**An Educated Democracy**

The trade union movement is an educated democracy. Like our schools, it has its dunces and its geniuses — but the general average is high, aware more often than not that only through efficient techniques, economic use of scarce materials and manpower can we win through and consolidate and improve our standard of living.

A broad and general acceptance of new techniques and mechanisation has been assisted, however, by the gradual and orderly development of them. There has been no spectacular or revolutionary development which, by itself, has displaced large sections of industrial workers. The invention of the internal combustion engine at the beginning of the century created more employment—not less. It encouraged existing industries and led to the development of new processes to meet its needs. Rubber, textiles, leather, electrical, oil and other industries shared in its success. Smaller developments were occurring all the time — all easily merging into our economy, creating no very serious problems.

The result of all this activity was a change in the incidence of employment between one industry and another, and indeed the creation of the largest labour market we have ever known. For every 100 people in employment in 1937, there are 131 today. The changing incidence is reflected in the fact that, as compared with 100 employees in 1937, textiles now employ 72, electrical industries 165 and the chemical industry 199.

Sometimes the effect of technological advance stretches beyond the boundary of industry and economic science itself and reaches out into the world of ideas, seemingly disconnected but probably resting on material foundations. The fact that the rotative steam engine was invented in 1783 has been connected in some minds with the abolition of slavery in the British Empire in 1833 and in the U.S.A. in 1863. This development of steam power, it is said, has challenged the economic as well as the moral basis of slave labour.

Whatever changes have taken place with the development of steam and other sources of power, remember that it was in 1819 that we passed an Act of Parliament to prevent children from being worked more than 72 hours a week. One hundred years ago, 60 hours constituted a normal working week: only fifty years ago an apprentice might work 54 hours a week, sometimes working 18 hours overtime. Today a 44-hour week is not uncommon, so in one hundred years we have had a reduction of over 25% in normal working hours.

**A Greater Demand**

During this period real wages have increased by some 250% and we can consider our own relative position compared with that of our parents or grandparents; we know that we demand and enjoy a wider range of creature comforts than they did. It is because of factors like these that, in spite of the greater manpower in employment and a higher output per man, we still have constant pressure on the family purse in the homes of this country.

The trade union movement generally looks at increased mechanisation constructively. We recognise that increased mechanisation and better technology produce considerably higher outputs. We recognise that we favour less blood and sweat than our forefathers experienced. In many cases we have certainly welcomed industrial consultants whose numbers are increasing and whose impact is now felt on the factory floor and in the office. We recognise that, despite reports of redundancy (incidentally, not necessarily caused by technological advances), labour is a scarce commodity and likely to be scarcer. By and large, the result of this has been to the benefit of the men at the work-bench.

We are in favour of the reduction of physical effort and, indeed, would support even more research in the machine-tool industry with greater thought and research on the human aspect, without detraction from the technical functioning of the machine. Too often great advances are made in the operative part of the tool at the expense of mental and physical energy of the worker.

Higher productivity through mechanisation means more output, more goods and more services. We are interested, therefore, in whether or no there will be greater spending power available to absorb the increased output and in order to raise the standard of living. Our policy is full employment and is, therefore, in step with technological improvements, more machines and more labour-saving equipment. We shall be constantly on our guard to protect the standard of living of our members on the short-term basis, even though we believe that in the long run all technological advance is to be welcomed.

**The Short-Term Aspect**

The trade union movement must always assess the impact of the world of ideas on its membership and, whilst accepting that technological change is inevitable and, indeed, to be welcomed, must consider the short-term aspect of any such change as well as the ultimate effect. There have been periods in our history when the so-called 'short-term' effect has lasted for years, yet in retrospect the development can be seen to have raised the standard of life. This must be so. How else can we explain the vast changes in equipment, techniques, automatic machinery, and the ever-rising national production figures, whilst at the same time noting that the working population is higher at 23.3 millions than ever before in our industrial history? Nevertheless, changes were taking place, possibly quite drastic for individuals or groups and, during the period of great unemployment, hidden by the general impact of that major situation of general unemployment, so that the technical change was barely noticed.

There can be no question that technical change creates the background for a higher standard of life; new demands are created, making the luxuries of thirty years ago the necessities of today; but all the time we, as leaders in our working-class

movement, must, whilst refusing to act as the Luddites of the last century and whilst accepting new techniques as inevitable and necessary, realise that we have a job to do to ensure that the fruits of higher productivity are equitably shared and that the social system is geared to take up the slack and cushion the effect of change upon those we represent.

The trouble with the age of Luddites was that the incentive genius of man was far ahead of the thought on the social consequences of change : we need not now be in that position. Apart from our own view of the need for technical progress, our economic position as a nation, with our extreme dependence on imports of food and raw materials to keep ourselves going, compels us to expose our productive efficiency to the hazard of international competition and to face up to acceptance of all new techniques developed anywhere : otherwise, we must watch our standard of life fall through inability to compete efficiently and so starve our native industries. That is our basic problem—the inevitability of accepting new mechanisation and new management techniques and the harnessing of them for the common good, both in the short and in the long run.

Much has been done already in various industries : new jobs have been created —new fabrics, new synthetics, new crafts : indeed, if we are to keep our position at all, there must be more and more changes, a gradual dropping of industries which the march of time has rendered obsolete in favour of new and coming projects and goods which will keep us amongst the forward nations of the world. I have already mentioned the changing relative position of various industries with regard to the numbers employed and this is of importance to us as trade unionists. It points the line of advance for continuous employment and, except for the more recent bad experience of the textile industry, is part of a continuous process, barely perceptible in a time of full employment but requiring, nevertheless, constant supervision by us.

**Development of Nuclear Power**

Sometimes a new development occurs which, both in the short- and in the long-term aspect, can be welcomed unreservedly. Its emergence conveys no possible threat—its need is so apparent. Of such a nature is the development of nuclear power for peaceful purposes. It is one of the ironies of life that war stimulates man's inventive powers and the atomic bomb arrived before any solution of its control for peaceful purposes.

Most of us learned at school that the atom was the smallest particle of matter entering into chemical combination, but that is about all we learned. We now know that atoms, which are so minute that it would take millions of them to cover a sixpence, have an even smaller nucleus which is built up of particles known as neutrons and protons. In ordinary chemical reactions between atoms (such as the burning of coal) the nucleus is not affected, with the result that only a moderate degree of energy is produced. But the fission (splitting) of the atom, involving changes in the nucleus, releases something like a million times the amount of energy produced by a chemical reaction. When one atom is split, it is possible to induce a "chain reaction" whereby the neutrons released from the first atom are used to split other atoms. This releases an ever-increasing number of neutrons. The neutrons and the fragments of the exploded atom fly out at an unbelievable speed, creating tremendous heat and, if uncontrolled, the result is the explosion of an atomic bomb.

The problem, therefore, has been to reduce the speed of the neutrons and harness the energy and heat they produce. There may be very startling developments from this power created by harnessing the atom in an atomic pile, but at the moment the main development is the use of the heat generated as a substitute for fossil fuels such as coal, thus creating electricity by an otherwise normal process. The importance of this to us cannot be over-emphasised. The increasing needs of industry for electricity and the failure of the coal industry to cater for our increasing needs at home and for the available export market create a position of very great seriousness to all our organised members. The coal industry in 1954 produced 215 million tons of coal : it was working in 1955 at a level of approximately 100,000 tons less per week, which appears to work out at a total tonnage for 1955 of 210 million tons approximately.

It is true that the coal industry has its own development programme, but the wastage of manpower and lack of adequate recruitment may mean that the development plan will not lead to any very great increase in the amount of coal produced. This situation must been seen in relation to the development plan which is absolutely

essential for the Electricity Authority. In 1954 the Electricity Authority covering the whole country used 38 million tons of coal. Its development plan will require 65 million tons of coal by 1965 and by 1975 will require 100 million tons. This latter figure, it will be seen, is almost half the total output of the coal industry as it was running last year. It means, therefore, that without some development to replace the failing coal industry, we as workers might find our very livelihood endangered through our industrial organisation being completely unable to run our industries efficiently and thus to compete in the markets of the world with the products we manufacture.

It will be seen, therefore, how providential it is that, in the Government White Paper entitled "A Programme of Nuclear Power", the development of nuclear reactors for the purposes of the Electricity Authority on the provisional programme will by 1965 be meeting one quarter of the total requirements of *new* generating capacity. The possibilities of expansion will depend to a great extent (as it says in the White Paper) on the speed with which the necessary techniques are mastered by industry at large. It is estimated that, if all goes well, it might be practicable by the early 1970's to expand the rate of construction of nuclear power stations to match our total requirements of new generating capacity. On this assumption, the total nuclear power station capacity installed by 1975 will be of the order of 10-15,000 megawatts, the whole of which could be used for base-load operation. If that programme is realised, it would mean that nuclear power stations would then be producing electricity at a rate equivalent to that produced by about 40 million tons of coal a year.

One of the possible consequences of all this is that in parts of the world which have been economically difficult, and remote areas where power could not be generated because of transport difficulties and lack of water for hydro-electric schemes, it may now be possible to build small nuclear power stations, as transport costs would be almost negligible. As regards heat value, one pound of nuclearly refined uranium or plutonium is equal to about 3 million lb. of coal, so that the transport of fuel for nuclear reactors is a simple problem.

There are hundreds of ancillary industries which may develop : for example, the production of radio isotopes for medical purposes used in the diagnosis and treatment of may kinds of diseases and tumours, and hopes are held out that radio isotopes may help towards eliminating cancer. Flaws in machinery and in metals can be detected more cheaply than by existing methods using X-rays.

We should remember that at the beginning of this century the development of the internal combustion engine led to a rapid growth in many industries—leather, oil, rubber, textiles to supply the growing automobile industry—and the possibilities appear limitless in this new development.

**Social Implications**

There are social implications, too, with regard to safety and health. One official publication in the United Kingdom has described work in a reactor plant as one of the safest of industrial employments. In the United States the injury rate is about half that in most comparable industries. It should always be borne in mind, of course, that reactors are still at about the same stage of development as the aeroplane was when the Blériot first crossed the English Channel.

Unfortunately all potential developments in technology cannot be seen so far ahead. We hear many views as to the possible effect of automation on the economic life of the United States and of this country and it may well be that we may be able to absorb a gradual change to automation in industries more naturally receptive to the principles than we are able to visualise at the present time. On the other hand, we could be in serious difficulty if there were a sudden upsurge and development of principles of this kind.

The question should be asked: "WHAT IS AUTOMATION?"

American trade unions have given a lot of thought to this and if I use some of their thinking in the following paragraphs, it is in order that we can better appreciate the magnitude of the problem. One of the C.I.O. Headquarters staff defined technology as the combination and operation of four things in an efficient organisation :

1. human effort and intelligence, called labour;

2. the use of energy resources in addition to human and animal muscle power;
3. machinery and instruments; and
4. the organisation and management of extraction and production in high volume;

all applied to the basic resources in the earth provided by a beneficent Creator, and added: "Automation is the accomplishment of a work task by an integrated power-driven mechanism entirely without the direct application of human energy, skill, intelligence or control."

He claimed that the evolution of technology to automation began with energy other than human and animal muscle power. Primitive workers applied their own physical strength and that of their draft animals to simple hand tools and machines. But men discovered and applied other energy sources—blowing wind, falling water, burning coal, distilling petroleum, generating electrical power and now harnessing atomic power. Power-driven machinery became an extension of man's muscle and man has been able to control the relatively simple machines with his body alone, even when they were power-driven. Today, however, machines may become so complex that man's power to control them is not great enough; thus instruments have been developed.

Instruments have evolved from the simple thermometer and wind gauge into delicately sensitive extensions of man's five senses—sight, hearing, smell, taste and feeling—and combinations of these. The perceptive senses of man have been extended by instruments beyond the ability of human beings. Instruments can look in two opposite directions at once, can work in inaccessible places, can work where the temperature cannot be endured or where light, sounds or smells are beyond human capacity. It appeared that automation had to wait until man's physical strength could be extended with energy and machines and his senses and judgment by instruments and control mechanisms. Instruments today are also devised to replace the human ability called prio-perception, i.e., the ability of man to anticipate what will happen next and to make corrections before an adverse happening occurs.

Automation really is a trinity composed of three developments and their application, *viz.*-

1. *Highly engineered mechanisation.* This gives rise to the statement that automation is nothing new. The development of power-driven machines to do special work like stamping, sawing, shearing, drilling, tapping, milling, etc., left the problem of transferring raw material and work in process to and from the separate machines. The first aspect of automation, therefore, is the "transfer machine" which is really a complex individual machine composed of units which are improved models of the formerly existing individual machines but arranged in such a way that the work in process transfers automatically from one unit to another, everything being indexed so that all units perform simultaneously their own function. The machine is improved or refined by processes which indicate when tools get dull and which anticipate breakdowns. It has great appeal for employers, especially in the metal working trades, because a large part of the cost in a mass-production factory is material handling, i.e., the human transfer of raw material and work in process by devices from one machine to another.

2. *"Feed Back" or "Closed Loop" Control.* A Harvard professor, Professor Weiner, says . . . "it is quite possible for a person to talk to a machine, a machine to a person, or a machine to a machine." He might have added that it can also talk to itself. The best illustrations I have read in simple terms of this imitation of a human function is as follows: A driver coming to a curve is required to turn the wheel accurately to stay on the road. He sees the curve, the brain is told to instruct the hand to turn the wheel, but no driver turns the wheel perfectly to match the curve. He overturns or underturns. If he overturns and stays that way, the car will cross the road into the approaching traffic lane and an accident will occur. So when he turns the wheel, the driver at once discerns that he has overturned or underturned through the human "closed loop" system and he makes a correction, automatically in the case of an experienced driver. This slight correction backward or forward is the result of a "feed back." Applied to a machine, this quality replaces the functions previously performed by a human operator.

3. *Electronic Computers.* These constitute the real key to automation. They are only eight years old, but rapid developments are taking place. As one writer says, they make it possible to do quickly things which, before this, man could not live long enough to do. Commencing this function through a vacuum tube or electron valve, the process now functions through the smaller transistor. Electronics replaces mechanics, and involved and elaborate calculations. Computers are equipped with "memories" so that information or data can be called forth when needed.

These three things combined add up to automation. The argument is still unsolved. Is automation only suitable for the long run, or can it be adapted for the short run ? We in the trade union movement have a job to make life tolerable in the short run and in the long run. The question for us to answer is whether this new technique will produce a more devastating effect on labour than has the more normal type of technical development. Today, for example, a leading British automobile manufacturer produces 5,000 vehicles every week, each one being a week's work for about four men, taking the total of employees as approximately 22,000 (the highest peace-time total). In 1950 it took six men, in 1948 eight men and in 1926 sixteen men. In Oakland, California, a new carbon dioxide plant costing £350,000 and producing 60 tons per day needs only two men to operate it. It produces five times the output of a plant which was built as recently as 1935.

The Soviet Union has a plant built in 1951 for making car pistons, starting with aluminium ingots and delivering the finished pistons, wrapped and packed in boxes of six. It is worked by nine men per shift and it turns out 3,500 pistons per day. The total staff has been cut by one quarter and production costs have been reduced by one half.

In Great Britain there is a plant which has essentially only one operator and which cost more than one million pounds—not, however, manufacturing motor-cars. Instances like these show that automation may serve to develop still further the process that has enabled this country to increase its productivity to the extent that we maintain twice as many people as we did 100 years ago and at a much higher standard of living. If the effect will be no greater than that (and it is difficult to assume that its general effect could be greater than a reduction of the labour requirements by three-quarters), then we may say that it is apparently possible that developments of this magnitude can even be absorbed, still leaving us with full employment. That is what has happened up to now.

**Widespread Effect**

On the other hand, will the effect be even greater and will it be widespread, covering every industry ? Will it affect office workers more than it will affect industrial workers ?

The American trade union leader, Walter P. Reuther, speaking before the Congressional Committee in October last year, quoted the introduction of an automatic two-way horizontal broaching machine for machining automobile cylinder heads which had cut direct labour costs between 1949 and 1954 by more than all the technological improvements made in this process during the previous 35 years and with an actual decline in the investment required.

In 1941 an American machine tool manufacturer would have used 162 machines, representing an investment of $243,000, to machine 108 cylinder heads per hour at a direct labour cost of 40 cents per piece. By 1949 it took 6 machines, representing an investment of $240,000, to turn out the same volume of produotion at a direct labour cost of 20 cents per piece. (The saving in manhour requirements is much greater than indicated by these figures, when the increase in wage rates between 1914 and 1949 is taken into account).

By 1954, however, those 6 machines had been replaced by a single automatic machine, representing an investment of only $230,000, for the same volume of production, and direct labour costs had been cut from 20 cents a piece in 1949 to 4 cents a piece in 1954—a reduction of 80% in five years.

Walter Reuther quoted further instances where similar computers are being used to make up payrolls, to prepare insurance premium notices and record payments, to prepare telephone bills, to take inventory, to control the operation of electric power generating plants, and for many similar purposes. One central

computer to be installed by the Ohio Edison Co., for example, will simultaneously control the operations of 35 generators in nine plants scattered over an area of 9,000 square miles.

Even automation itself is being automated. One of the bottlenecks, in the use of computers, to which data is fed by punched cards, has been the time required to have the information punched on the cards by trained operators. Now the Burroughs Corporation has produced for the First National City Bank of New York an electronic device which "reads" the serial numbers on travellers' cheques and reproduces them on punched cards at a rate of 7,200 cheques per hour, doing the work of ten highly skilled operators.

**The Potential Benefits**

From many points of view and from all long-term angles, the trade union movement must welcome automation. We fully appreciate its potential benefits; if only a fraction of what technologists promise for the future is true, automation could make possible a very much shorter working week, longer holidays, earlier retirement and a very much higher standard of life. It can bring freedom from monotonous drudgery, it can free us from routine and from repetitive jobs, it can develop higher skills.

Nevertheless, it produces its problems. It is said that it is cheaper to build new factories for automation than to alter existing premises. It could lead to a demand for more shift working. Another feature is that many of our large undertakings today are built in proximity to coal supplies and, with the advancing development of atomic energy plus automation, there is no limit to where industries might be established.

The other side of this picture was given at the same Congressional meeting by various representatives of business, who did not accept that the advent of automation would reduce the demand for labour. Mr. Davis, Vice-President of the Ford Motor Co., spoke of the early days of the Ford Model "T". Although there were only four cars registered in Chicago in 1895, they were banned from the streets, but the idea of automotive transportation took hold and in 1899 output reached 4,000. When in 1904 production went up to 23,000, the leading financial experts warned the car makers that they were dangerously over-expanded and would soon go bankrupt.

He claimed that it is now a matter of cold statistics, that the automobile has been responsible for 90% of employment in the petroleum industry, 80% in the rubber industry, 70% in the plate glass industry, 60% in alloy steel and substantial percentages in a great many other industries. He went on to say that the manufacture of the Model "T" was relatively simple compared with the production of modern car lines today. It had less than half the number of parts — 5,000 as against more than 10,000 in today's cars. They were made in any colour desired by the customer, so long as it was black!

Coming to the situation created by automation, he pointed out that it cannot be engineered into every job, since it is not always feasible or profitable. The Ford Company, which has automated the manufacture of engine components for the ordinary Ford engine, cannot justify the application of automation to the manufacture of engine components for the Tractor and Lincoln engines, due to their lower volume requirements.

What has been the effect of automation on the Ford labour force? Mr. Davis claimed that, instead of adversely affecting employment, automation has created better jobs, while at the same time making them safer and easier. In 1950, Ford and Mercury engines were built and assembled at the Casting Machine Plant and Motor Plant in the Rouge, and the Lincoln engine was built in the Lincoln-Detroit plant. In 1954, the Ford "6" and the Mercury engines were built at the Cleveland Plant, and the Ford "8" and Lincoln engines were built at the Dearborn Engine Plant. Engine production for these years was practically the same: 1,933,661 units in 1950 and 1,954,049 units in 1954, an increase of 1%. During the year 1950, a monthly average of 8,253 direct labour employees worked on engine production, compared to a monthly average of 6,399 such employees in 1954. What happened to the people apparently displaced by automation? Although there were 1,854 less direct labour personnel employed in 1954 than in 1950 on engine production, these people were absorbed in other operations. In addition, in 1954 there were 976 more

skilled maintenance personnel employed on engine manufacture than in 1950. On September 15th, 1955, there were no seniority employees on a laid-off status from either of the two plants.

One thing we must realise is that there is a lot of wild and over-dramatic thinking on automation in many quarters. Automation requires first of all automatic machinery and the development of automatic machinery does not necessarily need the development of electronics. The opportunity to automate often depends on the materials to be operated upon being rigid and unvarying in nature. It probably means long production runs, as otherwise the law of diminishing returns operates at an even earlier stage.

There is also sometimes too easy talk about the mobility of labour. I myself have quoted the transfer of labour which has gone on over the century between one industry and another and which will always proceed at a slower or quicker pace.

If automation was rapidly taken up after its practical possibilities had been proved, it would be no comfort to displaced workers to be told that jobs were available in other industries, maybe many miles from all the domestic and social contacts of the past. Nevertheless, that still may be necessary, but there is probably justice in our demand that, if that should happen, just as machinery is depreciated and made obsolescent over a period of years requiring financial arrangements to be made to that end, there is no more important aspect of industrial or social life than the human factors involved within it. Men should always be regarded as more important than machines.

**The Problem of Education**

There is the problem of education, too. If workers require upgrading — as I think is involved in this — it will be done through our technical colleges and professional institutions, thereby involving the younger elements of the human labour force. Very great care would be necessary in dealing with the older people in industry, as it would be invidious that, having created by new techniques a greater potentiality for future wealth and prosperity, casualties should be found amongst the older generation and a price exacted from them of lower wages and living conditions.

This whole problem may not, indeed, be only an industrial matter. It seems to me to have all the potentialities of one of the greatest political issues of the century. These new machines do not shop at the stores around the corner, and it would be invidious to create an automated class of worker accidentally paid at considerably higher rates than the non-automated group ; so, if the product of this neo-modern age is to be consumed, the purchasing power of the community as a whole must be of such dimensions as to ensure consumption does in fact take place.

The greatest problem is the facing up to the short-term aspect, even when we are convinced that in the long run all scientific advance is for the benefit of mankind. We only live in the short run ; in the long run we will all be dead. The long-term results may not automatically benefit mankind, but they must be made to conform.

There is plenty to do in the world — too much to leave to "laisser-faire" methods. There are vast markets in the undeveloped regions where the development of nuclear power and automation may be complementary one to the other. The development to self-government begins on an economic basis which hitherto has been lacking in much of the Commonwealth. Properly applied, with proper policies, we may have here the opportunity to bring quickly to fruition the ideas of the pioneers of our movement who saw the vision of a "parliament of the world" with populations living in plenty. The task ahead for the industrial and political movements is to help to realise the dreams of many who have long ago left the industrial and political scene.

# The Production Exhibition and Conference

## Olympia, London

## 23rd/31st May, 1956

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The sixteen Papers presented to the Production Conference are being published in the Journal. The June and July issues contained the Papers presented at the first seven Sessions, and this issue contains the following:

**SESSION VIII, 28th MAY**

**"Investing in Better Designing for Production"** by John Barnes.

**SESSION IX, 28th MAY**

**"Investing in Better Machine Tools"** by Sir Stanley Rawson.

**SESSION X, 28th MAY**

**"Investing in Better Quality Control and Inspection"** by Dr. Bernard Dudding, M.B.E., Ph.D., F.Inst.P.

**SESSION XI, 29th MAY**

**"Investing in Simplification and Standardisation"** by Professor H. W. Martin.

**SESSION XII, 29th MAY**

**"Investing in Work Study"** by A. J. Speakman.

# INVESTING IN BETTER DESIGNING FOR PRODUCTION

by JOHN BARNES

J. Barnes

*Mr. Barnes was educated at the Birmingham College of Art, and passed the Board of Education Examinations in Industrial Design (now the National Diploma of Design).*

*He began his career as a publicity artist, but soon changed to industrial design and became staff designer to Sperryn and Company, Birmingham, followed by a staff design appointment with Pilkington Bros. until the outbreak of the Second World War. After army service in France and Africa, Mr. Barnes joined Allen Bowden, Ltd., soon after demobilisation, as Chief Product Designer, and was later appointed to the Board of Directors.*

*He is greatly interested in the promotion of better design in England and has lectured extensively on the subject both in this country and recently in Germany. He is the Visiting Specialist Lecturer at the Birmingham College of Art in the School of Industrial Design; a member of the Society of Industrial Artists; a member of the original Register of Designers; and for four years was Chairman of the Midland Industrial Designers Association.*

THERE still exists in industry a tendency to view the Industrial Designer with some suspicion, based on the assumption that art and industry have nothing very much in common and that if " tarting up " of products is desirable it can be done by the engineers on the job. This, as experience now proves, is not good enough, and if continued as a policy may have serious consequences to our overseas trade during the difficult years to come.

We in Great Britain have a long tradition of manufacturing ability; but the days when England was the workshop of the world and invention could ride roughshod over design have passed away forever. Now is the time to reassess our potential in the light of the competitive designs of other nations and to lay our traditional mangle design for all time.

It is true to say that Industrial Design is, to some extent, international; but it is both possible and desirable to infuse into design some national characteristics and there is no doubt that designers in this country are as capable as in any other.

It is customary to look upon America as leaders in the field of product design; but this leadership is not so much the result of superior design ability as an understanding by the designers of that nation's industrial economy. The general policy of American industry is to design for obsolescence, their vast output of consumer merchandise permitting frequent redesign and retooling.

We in this country, however, generally have to design for much smaller annual markets, which fact mitigates against frequent design changes as it engenders in manufacturers an understandable caution towards very progressive design if such would entail or might necessitate the wholesale scrapping of expensive tools, the cost of which may not have been amortised. Also, we have a tendency towards conserving basic stocks due to our need to import certain raw materials which cannot be easily replaced and must, therefore, be used with due care and discretion.

This cautionary attitude on the part of manufac-

turers is all the more understandable when taking into account the general purchasing attitude of the British public who are more discriminating than is the case in America, where products are bought in the full knowledge that next year they will be " style obsolete," and which knowledge tends to make the selection of well-designed products less important. The British attitude could, in fact, have a very useful influence on our future design policy since it tends to encourage designers to create work of a more worth-while and lasting quality. At the same time it tends to raise the standards of taste of the nation.

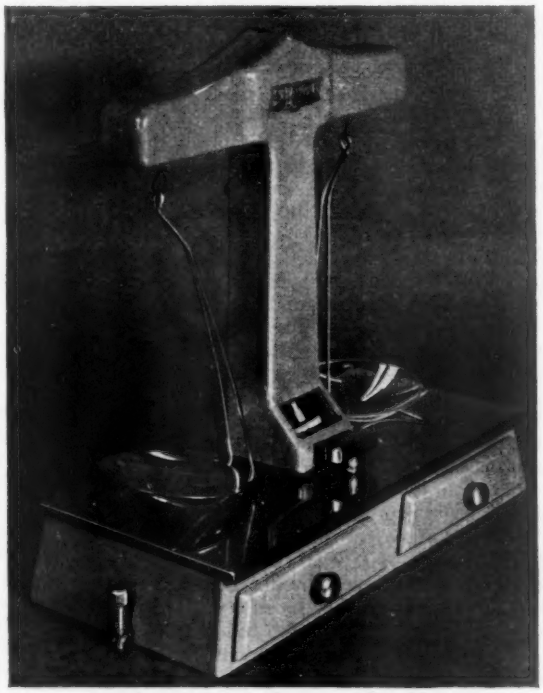
**Background**

It is inevitable when discussing the practice of Industrial Design that a brief note on its history should be included as it will prove helpful in assessing the worth of modern design and, I hope, give confidence to the sceptical that we have higher principals and more honest intentions than our predecessors.

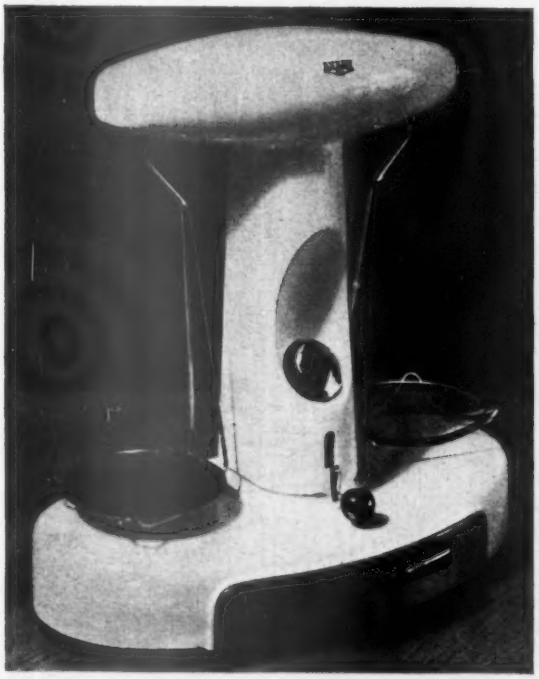
William Morris, who began his Arts and Crafts movement in 1866, was a man of high ideals; but the repercussions from his craft revival movement have probably retarded our progress by 50 years. He it was who condemned the machine and exhorted all to turn their eyes from the future and search for inspiration in the great works of the Gothic period.

This teaching has, to some extent, become a trait in our character. The search for a prototype in all things is still a tendency when introducing something new, and thus we find the first internal combustion engines attached to the horseless carriage, we see radio cabinets tricked out to look like Jacobean sideboards, and even water closets sometimes appeared in the guise of dolphin-encrusted decorative fountains. These examples, it is true, are typical of the early days of the Industrial Revolution; but the tendency persists to this day in a modified form.

What we all have to do is appreciate that everything is moving faster and faster and design styles are now arriving and passing with such rapidity that it is no longer possible to sit back and copy what our fathers did. This ever-increasing tempo is by no means occasioned by Industrial Designers furiously casting



**Original Dispensing Scale in cast iron.**
This shows clearly that there is no sympathy with the material. All the surfaces are flat, which exaggerates imperfections in the casting and prevents the vitreous enamel from flowing properly. The rectangular tapering base might just as well be folded from sheet steel. The method of securing the column to the base makes cleaning extremely difficult ; and cleaning is of first importance when all manner of chemical powders are being weighed.

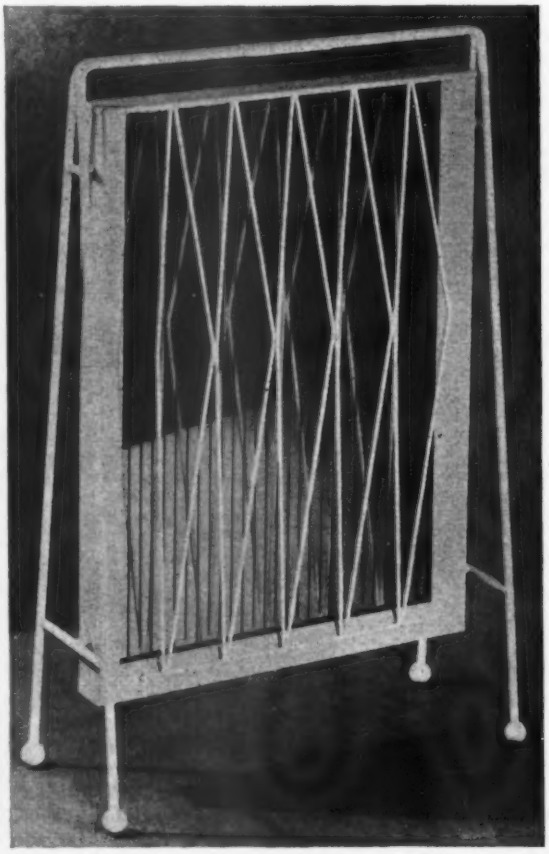


**Dispensing Scale designed for W. & T. Avery Ltd.**
The new design in vitreous enamelled cast iron has generally rounded and cambered surfaces to assist casting and enamelling. All the parts have been co-ordinated and the base casting is provided with a generous sweep upwards over which the column is fixed, making cleaning very simple. One weight draw is used instead of two as before, which helps to simplify the design. The influence of certain types of modern sculpture is clearly seen in the re-entrant surface which accommodates the indicator reading aperture. This design also demonstrates opposing textures by using thin stainless steel supports for the pans in contrast to the solid cast iron of the remainder of the scale

bread on the waters, but is forced upon us by new materials, new methods of production and higher efficiency of mechanisation.

Throughout the history of mankind there is ample evidence to show that most things were designed to last and were made with loving care for use by succeeding generations; but this attitude of mind should no longer obtain. I read in a newspaper recently that " we must plan for the short run, in the long run we shall be dead," and that is, I am afraid, the only attitude we can adopt to the problem of Industrial Design for mass-production.

It is important at this stage to make it quite clear that designing for a short life is by no means synonymous with either bad design or bad workmanship, or indeed the use of inferior materials; but it does relieve the designer, to some extent, from the responsibility of designing for posterity, a responsibility that the architect still must face. It also should allow manufacturers and designers a freer hand with products which must sell through public acceptance.



**1 kW Glass Panel Heater, designed for The Hotpoint Electric Appliance Co. Ltd.**
Designed for simple break-press parts with fabricated steel rod frame and guard. This design shows the permissible influence of the " contemporary " style and is intended to harmonise with modern furniture and " contemporary " schemes of interior decoration.

To return to history, however, we have, in less than 100 years, experienced six different styles: Arts and Crafts (Gothic revival and revulsion for the machine) Art Nouveau (surface decoration principally derived from attenuated plant forms) Jazz Modern (two dimensional, mainly based on geometrical forms and influenced by cubism) Functionalism (mainly attributed to the Bauhaus), Borax style (emanating from America and noteworthy for useless chromium-plated decoration), and, finally, our own Modern Style.

A considered examination of these periods shows that in the first three production engineering was never accounted important. All that was considered was new experiments in style, and it was always up to the manufacturers to prostitute his materials and devise means to make his machine produce the latest whims of the artist designer. So we can pass over these three since they have contributed very little to the general movement forward, and were more concerned with two-dimensional pattern than an honest attempt to formulate a style for the machine.

It would be unfair to direct this criticism towards the designers of the functionalist period who were so preoccupied with function that they forgot the human element. They did, however, recognise the machine as a means of producing a new art, although most of their work was directed towards its ultimate use in relation to architecture. They did not get very far in the movement towards the plastic form so appropriate to mass-production, although there is no doubt that they would have done so had the Bauhaus survived the advent of the Third Reich.

**Modern Design**

The difference which exists between the styles of the past and the style of today is very marked and encourages me to believe that out of the chaos of mechanisation a new industrial art is beginning to appear.

This new art is not (as has always been the case in the past) based on a new twist to pattern and decoration, but is an honest endeavour to equate " design " to machines, production and the consumer. We have at last thrown off our preoccupation with forcing machines to reproduce imitation hand craftsmanship. We can foresee the dangers of mass producing the phoney craft *objet d'art* which, when damaged, is replaceable piecemeal by unskilled labour and which can thus prolong the life of a dubious design long after it is style-obsolete and functionally inept.

The dangers, therefore, of consciously searching for a new form of decoration cannot be overstressed; but decoration we must have if sales are to be maintained in consumer goods. Some surface interest would seem to be legitimate in the treatment of knobs, handles, lettering, air inlet ducts, grilles and openings that have to be there but which can be treated in a variety of ways which rely, for their aesthetic quality, on the ingenuity of the Industrial Designer. Their vestigial function acts as a salve to his conscience.

The domestic free-standing refrigerator is a typical example of consumer product design. The housing,

as a design, has reached its conclusion by present production methods and tried materials; but that the door handle is always fair game for the designer is evident by the large number of refrigerators on the market all similar in general, but without two handles alike. It would be a sad day if the handle designs ran out and " Adam " swags and husks, " genuine hand-painted " and repeated one hundred thousand times, adorned the fronts.

The basis of modern design for mass production is on sounder foundations than the surface decoration tricks mentioned above, and might be said to have its very origin in the machine and mass-production methods.

If you examine the illustrations, you will notice the constant recurrence of a certain profile. It appears in plan and elevation in many of my designs and, whilst it may well be described as a cliché, it has far more logic behind it than the puerile efforts of the artist-designer of the past whose services were exclusively used to apply sickly ornament to all things.

This profile line might be described as the line of beauty of our time. It stems from the discipline imposed on the Industrial Designer by methods of production. It will be seen that it is formed from two slow parabolic curves thus:—

springing from a proportionately small radiused corner and providing all the surface form required. It is infinitely variable. For plastic moulding, for die-casting, for sand casting and for pressing, it provides appropriate " leave " and assists " flow." It adds strength to materials and presents the best surface for paint or vitreous enamel.

It is not, of course, possible to apply it *ad lib* as the answer to all design problems. The proportions of the cambers in relation to each other and the disposition of the corner radii to make the best use of the highlights is the designer's province; but it is at least a tangible line which can be explained, excused and used.

It has probably never been necessary in the past to explain why a piece of craftsmanship looked like it does or why an artist reached a certain conclusion; but now we are asked to give a reason for every move in the game. Our designs are dissected to the last detail and that is why I felt it necessary, in this Paper, to give tangible reasons for phenomena that appear in a very inexact science.

The rules of design mentioned above do not dispose of all the shots in the locker. There are many tried and useful approaches to every problem which reduce themselves to proportion, disposition of parts, the juxtaposition of differing textures, the selection and arrangement of colours, the use of re-entrant surfaces (negative volume) and a trained and inborn sense of rightness in the Industrial Designer.

From this it will be seen that the application of industrial design to the diverse products that come the way of the designer is not a matter of adding chrome trim and acorn nuts, but is essentially a fundamental matter affecting every aspect of the product. It is true that, quite often, one is presented with a mechanism that is proved and in production or in process of tooling-up. Then we can only do our best and become stylists; which is the title allotted to those who concern themselves with outward appearance to the exclusion of the more basic problems that properly face the Industrial Designer.

**Industrial Design**

The Industrial Designer is aptly dubbed by Mr. John Gloag " the missing technician," and this well describes his place in modern industry. He forms the link between the engineer and the aesthete.

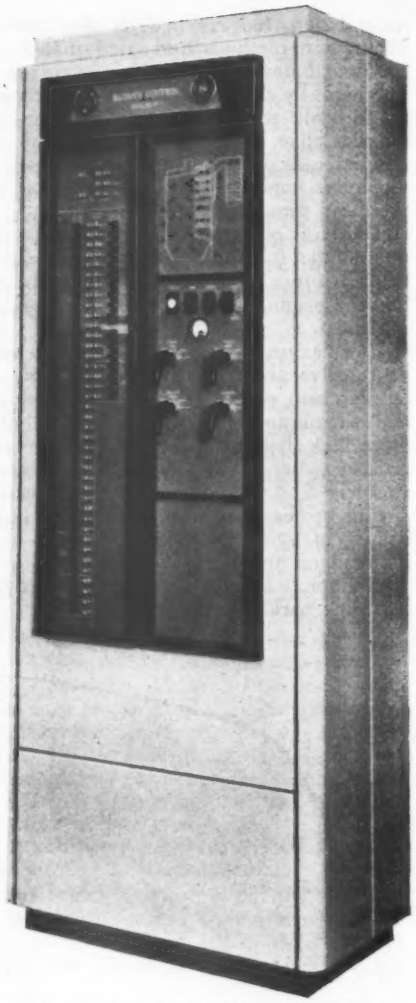
It may be said that the aesthete plays no part in the race for complete mechanisation; but we have the example of the nineteenth century to refer to if in doubt. We can see that at the beginning of the 19th century the nation was so preoccupied with invention and science that there was no conscious effort made by manufacturers to try and produce designs of character, in spite of the fact that they still harboured ideas of constructing for posterity such as had been the practice from time immemorial. The Catalogue of the Great Exhibition of 1851, apart from a few notable exceptions, proves this I think.

We live in a time of perpetual change and it is the overdue realisation that we are designing for obsolescence that makes the need for Industrial Design so much more real than ever before. We live in an age of specialisation, and product design is a specialist's province. No longer is it wise for a manufacturer to risk marketing his products party-styled by " a lad who is 'andy with a pencil."

This practice is still too rife for economic safety. Competition grows apace and one can feel certain that every product exported from America has had the benefit of a competent Industrial Designer. This is also becoming the rule in Germany, too, where very competent Design Consultants are beginning to flourish, soon to be reinforced by American Consultants' branch offices. Already " designed by Raymond Leowey " is to be seen in the German shops.

It must be plain that our country's economy demands that our unquestioned inventive genius and manufacturing ability should be reinforced by better appearance design. It is our duty to observe the designs from competitive countries, particularly America. I base this thesis on the fact that the American glossy magazine finds its way into every corner of the earth, each copy crammed with coloured illustrated advertisements of the latest designs in every

**The original type of Soot Blower Cubicle.**
Showing the "custom built" system and the ill considered random placing of the extraneous parts.



**Soot Blower Cubicle designed for The British Thomson-Houston Co. Ltd.**
This design shows the simplicity that can be attained by the modular system of construction. The grouping of the controls into a single frame gives unity to the design.

field of manufacture. It is upon these that the taste of the civilised world is largely based, and for export markets we will do well to examine these designs and perhaps be influenced even to the extent of submerging our national characteristics to some extent.

The industrial designers of Britain are no less competent than their American counterparts. It is true that, for the most part, we blush unseen; but it is no part of the British character to indulge in nation-wide personal publicity, nor would it seem part of the British character to bother very much to enquire who designed the product he purchases.

It would, however, be wrong, in my opinion, for British manufacturers to enlist the services of American designers, competent as they are, because they inevitably infuse entirely American characteristics into their work and must, from habit, be influenced by their experience of American production methods geared as they are to an astronomical output.

The British designer, on the other hand, is used to designing for batch production. He is used to relying on ingenuity to reincarnate some well-tried old parts of which there are fifty thousand in the stores and a set of tools with ten more years of life.

I do not speak in a disparaging way of these con-

ditions. In fact, I see no great prospect of them changing in the forseeable future, and it may well be that our national design style will be derived from this discipline and the knowledge that the forward movement of design is a comparatively gradual process firmly based on public acceptance.

It is quite incorrect to assume that the Industrial Designer works as an isolated individual and it is a crime to send him off to produce a design without first acquainting him with all the facts. Nor is it reasonable to expect him to hatch something practical and entirely new in the seclusion of his own office. Designing today is very much a team job and each member should contribute his due share.

My experience has proved, many times over, that manufacturers are experts in making and marketing of their products and, therefore, the Industrial Designer should never attempt to tell him how to do his job. Every branch of industry knows all the facts of its trade and this hereditary experience should be at the disposal of the Consultant Designer. Only under these conditions can a worthwhile design be achieved.

One of the problems of the modern Industrial Designer results from the knowledge that he is designing for thousands of patrons he will never meet, and this is the significant difference between the designer-craftsman of the past who created single pieces to suit the taste of his patron and the Designer to today, who must be able to view a design through eyes more attuned to the mood of the general public who are the prospective purchasers.

He must have this feeling for public acceptance and never force an experimental design on an unsuspecting client to gratify a personal desire to jump too far ahead. It is no part of his duty to design his client out of business. Rather, he should be able to judge how far ahead of competitors it is safe to go, bearing in mind that the true test of a design comes at the point of sale where the prospective purchaser will make comparisons with competitive products offered side by side.

In this country it is not usual for Industrial Designers to engage in market research. Although my own group used to offer this service, manufacturers seldom availed themselves of it, they understandably preferring to be guided by what was selling and where, and consulting their own sales staff when deciding what next to market. This is, of course, a logical attitude and, after all, there are always the many Trade Associations or the Board of Trade ready to give further authoritative advice, should such be needed.

From time to time I have attended gatherings where a new design, in prototype or model form, is exhibited to a carefully selected audience of both sexes of varying income groups and their reactions recorded. This process can be both diverting and embarrassing for the Designer, especially when most of the participants are shy and determined to give the right answer. For instance, the whole exercise can be made useless by an unfortunate choice of colour, particularly when ladies are involved and when the design can be damned because several of them " never could abide blue," but when asked to visualise the design in another colour are incapable of submerging their blue phobia. Consequently, the findings of these quiz teams may only establish that Maisie and Rose never did like blue.

It is the Consultant's duty to advise his client on matters relating to lettering and packaging, and certainly make proposals for the use of new materials that inevitably come to his notice in the course of his normal contact with many industries, never, of course, disclosing the secrets of one client to another.

Whilst it is reasonable to expect the Industrial Designer to make proposals in respect of methods of manufacture and materials, it is more usual for his client to do this, for the reason that most manufacturers have preferred methods of manufacture and are often not able to put down additional plant for a process that is special to a new design. Quite often an alteration in method of manufacture can make a valuable machine tool redundant, and unless the Designer can justify such a sacrifice he would do

**Oil Heater designed for Joseph Sankey & Sons Ltd.** Unfortunately no photograph exists of the earlier model of this heater which was so style obsolete that sales had fallen literally to nil. The redesign shows how cambers and radii can assist in appearance and strength. It also demonstrates the value of textures ; the sides and lower portion being crackle finished and the door and top vitreous enamelled. It was not possible to curve the door, which would have been an advantage for vitreous enamelling, as it had to line up with the bottom pressing, for which tools already existed.

**Original Tobacco Scale in cast iron.**
The housing comprised two castings with machined joints requiring mating of the two parts which had to be handled as a matched pair throughout manufacture. The stainless steel bezel and inspection cover and the huge trademark greatly detract from comfortable reading. The machined pad on the base, to locate with the housing, forms a pocket which was difficult to keep clean.

**Tobacco Scale designed for W. & T. Avery Ltd.**
The new design has a pressure diecast housing and base and the machining of joints is made unnecessary by using a P.V.C. sealing strip. The pairing of the two halves is unnecessary for the same reason. The housing is designed to overhang the deep projection on the base which conceals the joint, and facilitates cleaning. The levelling feet have been set back out of sight and all the distracting appendages of its predecessor removed. The slight "V" on the centre line of the housing is only permissible in metal when die cast or pressed, as any need for fettling would ruin the effect which is designed to "break up" a large flat area and add interest by locating the light reflection to one side or the other.

better to design within the scope of the machines available.

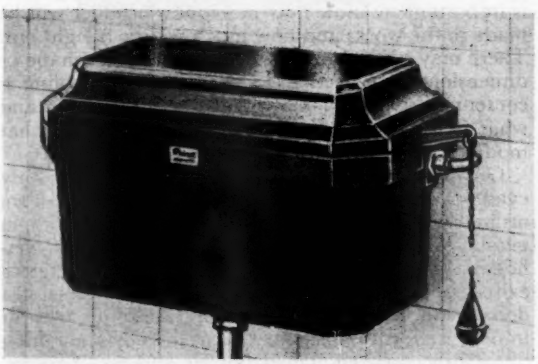
Industrial Designers must be, to a great degree, specialists in a limited field. By this I mean that it is unlikely that a man can be a competent product designer, an able wallpaper designer, a jewellery designer, a fabric designer, a typographer, and a specialist in the design of ladies' handbags. All these trades need special knowledge, and if the professional designer is to be worth his salt he must be competent in his own particular field in order to out-design competitors. Otherwise "the lad with the pencil" is far more economical and probably adds to his value by filling ink wells and brewing tea as well.

This brief review of the Industrial Designers' place in Industry must be thought of in the light of economics. That more and more manufacturers are obliged to design for style obsolescence is abundantly evident from the manner in which the whole nation interests itself in the Motor Show, waiting to see and compare the new models before placing their orders; and this would seem a healthy thing for the nation's economy.

It is estimated that in America two cars in every five are bought each year due to style obsolescence. This method of increasing sales volume must inevitably spread to many industries concerned with consumer goods and indicates the growing importance of design coupled with good product engineering and prestige.

It is axiomatic that succeeding design changes must of a necessity be the result of a team of designers both artistic and mechanical, and the greater the liaison between the factions the better and cheaper will be the product and the greater the sales.

It is an investment of considerable importance to have a design policy of a permanent nature. It is no longer safe to produce something new every five or ten years, nor is it wise to wait and see what your competitor can sell best. There is no time to wait



**The Original Cistern.**

This follows the pre-war fashion in sanitary ware relying on the chamfered corners for effect. The design has none of the qualities of moulded plastic and might just as well be made of wood. The inherent qualities of materials should be evident in a good design and the form should reflect the process of manufacture.

**The "Lynx" Cistern designed for Shires & Co. (London) Ltd.**

A redesigned product in moulded plastic reflecting the character of the material and bringing out its best qualities by the use of cambers and radii to assist "flow" and avoiding the undesirable surface appearance of flat areas in moulded plastics. The aluminium cover bead is fitted to conceal the possible discrepancies between the lid and the body caused by unpredictable variations in shrinkage. It also acts as a decorative trim. This design has played a big part in elevating the Company to the position of the largest manufacturers of cisterns in the world.

when we are rapidly approaching the time when a new design is an annual occurrence. Industrial Design is an important investment which should be considered in relation to development and tooling expenditure. It is not a new overhead expense in a Company's economy.

I often wonder why publicity is an accepted outlay for which large cheques are signed without a second thought, whereas Industrial Design is usually viewed with shrugs of resignation and the fee demands frequently subjected to minute examination. Perhaps, one day soon, the Industrial Designer will enjoy the confidence of industry to the full. This state of affairs can come about by several ways; but it seems most likely that it will be the result of growing trust and the knowledge that the Industrial Designer comes, not as an arrogant art pedlar, but humbly to take his rightful place in a production team to infuse new blood into a firm bogged down by too much knowledge of their own small sphere.

He must, to a tremendous degree, be a man with a mission. That is to say, his first objective is to increase sales by better design but, at the same time, he must work towards improving public taste by gradual degrees, never inflicting designs upon his clients for his own gratification and ignoring the chances of public acceptance. The Designer who persuades his client to embark on a vast and expensive tooling programme for the mass production of thousands of products for their photogenic qualities and his personal exaltation, has no place in the industrial teams that are devised to give the public what they want at the most reasonable price.

**Practice**

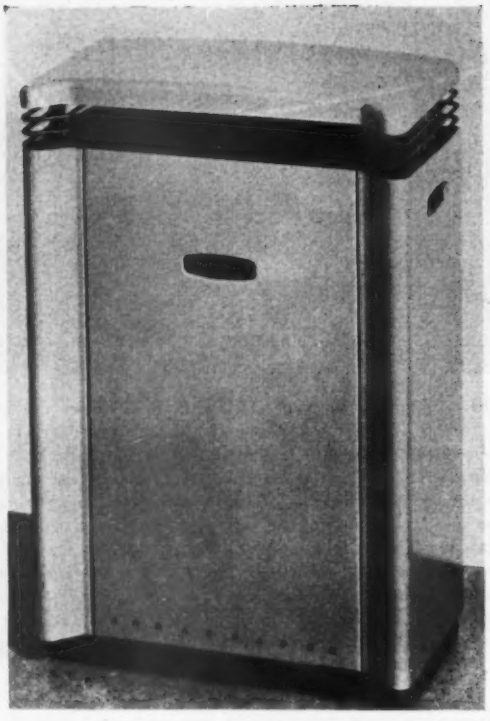
The successful practice of industrial design, in my opinion, can only be done by a group comprising Engineers, Architects and Industrial Designers. The complexity of the modern mass-produced product makes this inevitable. By this group system, the designer has the advantage of his own team and his client's team, and having one's own engineers on hand can save a lot of travelling and provides a staff of draughtsmen who are trained properly to interpret a design.

The group with whom I work endeavour to confine their activities exclusively to the light mechanical and electrical engineering industries, although we do some Exhibition Stand design for our established clients. Thus, by limiting our activities to those spheres in which we are competent, we feel that we can give a better service to industry. If we decided to design in other fields we would feel obliged to increase our staff to include specialists in other branches of design.

Some time ago I was asked to design some porcelain sanitary ware, a request which followed a successful design in plastics. In this case I spent some time in the Potteries learning the do's and don'ts of slip moulding; but this was an isolated case where we felt that the employment of a specialist was hardly necessary.

The general practice of Industrial Design does not follow a common pattern, but is tailored to suit the requirements of the client. I will, however, trace through the processes of a fairly usual sequence.

We will assume that a manufacturer has not



**The "Ambassador" Convector Heater, designed for Joseph Sankey & Sons Ltd.**

This design makes use of certain break-press components which, to some extent, are reflected in the general form. The top is a deep drawn component which gives it sufficient strength to make it capable of tying the side members rigidly into place. The plunged holes, instead of applied handles, showed a considerable saving in cost.

employed a Consultant Designer before and wishes to engage on, and invest in, a new design policy.

First, he must select his designer. He can do this by hearing of a Designer from an associate, he can advertise in the appropriate magazine or newspaper, or, and what is probably best, he can contact the Council of Industrial Design who carry a register of available Designers, and will supply the names of one or two Designers best suited to the problem in hand.

Having selected the Designer, the opening gambit usually revolves around a discussion regarding a first tentative product which is generally used as a test piece and is destined to provide the manufacturer with an insight into the Designer's character and ability. It is of vital importance that he and his organisation will " fit in " with the production team and the sales side. This initial discussion is usually, and advisedly, at a high level, as unless top management are enthusiastic about a design policy there is little hope of ultimate success. Top management must also infuse their thoughts into the minds of their subordinates.

Having discussed the product, we need to spend some time in the works in an endeavour to assess the capabilities of the plant and observe any special machines or processes that may affect the design. It is important to know how much of a product will be made in the works and how much will be bought out. There may be ways of finishing which affect shape or dimensions; we need to know how much tooling is contemplated; how many parts already exist and what is to be used from the previous model; what modified and what discarded; etc.

Obviously, many questions are asked to which only evasive replies would be given if they came from ordinary visitors; but there must be no hesitancy in giving information to the Designer, however confidential it may be as, unless complete confidence exists between his client and him, the progress of a design can be greatly impeded. Absolute trust is imperative for it is necessary for us to know something of factory costs, envisaged output and retail prices, etc., all of which can have a marked effect on the design.

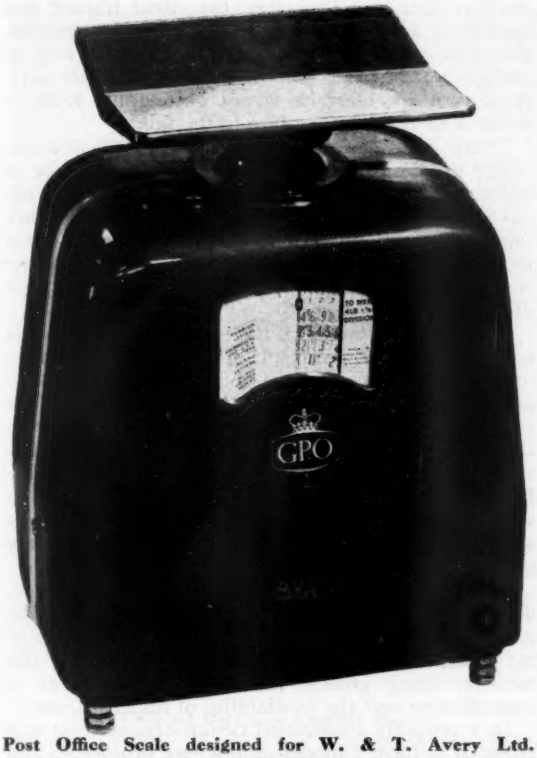
We do not normally do any costing; but constant liaison with the client quickly enables us to learn which processes he finds expensive and which he prefers, and this favouring of one process or another changes in different factories and different localities.

The tour of the works is followed by a meeting with the heads of departments concerned, usually the Production Engineer, the Chief Engineer, and the Sales Manager. These three gentlemen should be fully conversant with the project from the start, as the knowledge of their own product and organisation and their views on competitors' products can be of inestimable assistance to the designer.

It is very unsatisfactory to start on a design project without full knowledge of similar products already on the market, and it is very necessary for these to be available for close study. This is not done with the object of copying or modifying. In fact, the reverse is the case, one of the important reasons being to know what to avoid. In simple products it is only too easy to reach a solution very similar to one already on the market. It is possible too, when studying the products of competitors, to assess the trend in design and decide how far to advance ahead of those already available in the shops; and this gives me the opportunity of again stressing that Industrial Design is not an experiment in revolutionary ideas, but is essentially geared to estimated public acceptance.

It is often said that motor cars, particularly American ones, look alike. Well, basically, they do, because no motor manufacturer can afford the vast outlay in development and tooling that a new design demands without very careful consideration of what will sell. In 1935, the Chrysler Corporation introduced a new model, " The Airflow," which was, at that time, a very progressive design; but they had gone too far ahead of public demand and the experiment nearly closed them down. This example of designing too far ahead has since directed the American motor manufacturers into a more conservative, but still progressive, style policy.

At or very soon after the initial meeting, methods of manufacture are discussed, when we may make proposals regarding production which we think may




**Post Office Scale designed for W. & T. Avery Ltd.** For installation in Post Offices throughout the country. This design was prompted by a request from the G.P.O. for a postal scale of 4 lb. capacity and a consequent increase in chart length to 16″. The indicator is now stationary and concentrates the vision at one point, which makes for quick accurate reading. The machining of the joints is now obviated by the use of a P.V.C. joint strip and the base casting has been dispensed with. The goods plate is designed as a shallow "V" which serves the same purpose as the original spigots but is much more readily wiped over. The lettering has been considered in relation to the new design.

**The original familiar design of Postal Scale.** Used in all Post Offices, it has an 8″ chart permitting a limited amount of information and a moving indicator. The housing is of two parts, the joints of which are accurately machined at considerable cost and have to be paired with the consequent difficulties of keeping the machined pairs together throughout manufacture. The base is a separate casting and can be screwed to the counter, this requirement being necessitated by the sensitive mechanism. The goods plate is provided with four spigots to prevent cylindrical parcels from rolling off. The lettering is ill-considered.

affect the appearance directly. For instance, if it is decided to fabricate the steelwork from break-press components, we would avoid spherical radii at the corners, would ensure that the shape would permit of clear access for the electrodes of spot-welders, and so shape the housing that welding could not cause warpage. All these aspects, and they are legion, affect the Industrial Designer very acutely and guide him towards a logical solution.

Having then been properly briefed, and it is essential that we should be, particularly if the client has experienced special circumstances in connection with his products or is governed by British Standards or any other restricting device, we return to our own office to commence work on the new project.

If we are to re-design an existing product we begin by a careful study to decide how best to improve it both in appearance and ease of production, having due regard to function (which includes the shape and disposition of controls) the use of colours in relation to the assembly, and the effects of the preferred method of manufacture upon the appearance.

We then begin the actual design.

The best method is to prepare alternative ideas in pencil perspective form, perspective drawing being really a must in visualisation since our concern is essentially with three-dimensional form. Authographic drawings do not give a true picture of a product which we know will be seen from a certain eye level from one or many viewpoints. Sculptural shapes with complex sections are never easily drawn authographically (in fact, some of them cannot be so drawn to finality) and if they were so drawn, they could easily confuse owing to them having to bear lines, points of intersection, etc., that would not, in actual fact, exist or be visible on the three-dimensional object—hence the necessity of perspectives.

Having completed a number of possible solutions

n perspective sketch form, including part views to illustrate points and details, we have a meeting in my office where my engineering colleagues proceed to evaluate my proposals and advise me regarding any aspects which depart materially from production practice. They also supply the necessary calculations relating to material strengths, gauges of metal, bolt sizes, etc.

Following this internal meeting I begin the next stage which is the preparation of visuals of alternative proposals, these being carefully drawn in perspective in colour to show as nearly as possible the final appearance of the product. Quite often it is necessary for me to make clay models to prove certain points and these models also have to be accurate, or they are worthless. It is usual, when making clay models, to set out the design carefully in plan and fasten a wooden mock-up of the internal parts or mechanism to the board and work on top of this armature. Should part of the proposed contour be too deep or wrongly formed, the wood shows through, indicating that the design needs revision.

Incidentally, the visuals are only made after outline drawings have been prepared. These latter are done in my office and are not intended as general arrangements, but are merely to ensure that the internal mechanism can be properly housed and that access, where necessary, is not impaired.

The visuals are then submitted to the client and fully discussed. At this meeting the Industrial Designer should be able to state his views clearly and advise his client which, in his opinion, he ought to develop further. Too often the client himself sets himself up as the final arbiter—which is understandable, since it is he who is taking the risks real or imaginary; but one cannot help feeling that if he employs a specialist he is not getting his money's worth if he does not use him to the full.

**Three-stage Car Lift Jack designed for R. T. Shelley Ltd.** Incorporating existing internal machined parts. The body is cast iron and shows clearly the relationship between certain products and modern sculpture. The necessary stiffening piece has been given an opening to provide a handle.

There is, of course, the not uncommon situation where the designer strongly urges the acceptance of a design that the client's experience makes him not too sure about. So it is of the greatest importance that the Consultant Designer and his client be on such terms of full understanding as will allow both to make concessions, and which quite often produces the best design.

Many of the designs on the market which bear my name are, in fact, the result of co-operation between myself as the originator of the appearance and my associates on one hand and, on the other, the client's team who have the brand of vision which ensures that the best of both viewpoints is retained. In fact, in some cases it would be a gross over-statement were I to claim to have " designed " some of the products with which I and my organisation have been closely associated and which have been undoubtedly successful.

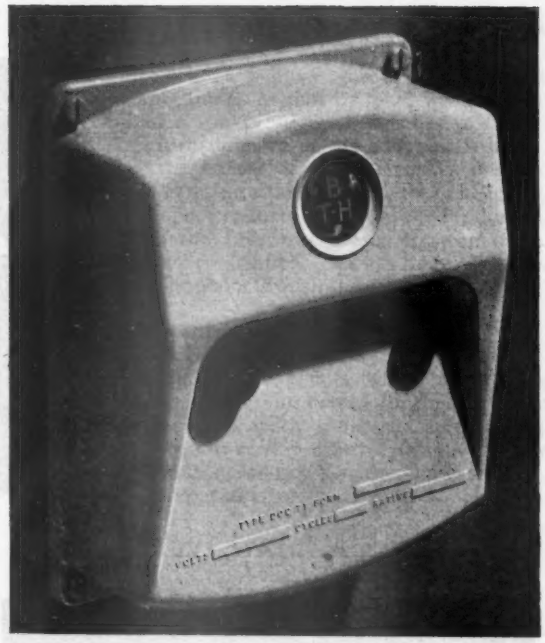
At the meeting at which the visuals are submitted, a decision is usually made as to which design shall be developed. This may be an unaltered selection or may be part of one and a feature of another, this decision being greatly influenced by the cost of manufacture and the availability of materials, etc.

In a properly constituted design organisation it is essential to have a model-shop where prototypes and mock-ups can be made, and it is usual for us to produce a model of a new product which is accurately made and, by a process that we have developed, finished to look exactly like the actual job. Obviously it is very false economy to begin production drawings direct from the Designer's visual when a huge investment in tools for mass-production is contemplated. Hence the necessity of a model and the advisability of the Designer making or supervising the making of it, so that he can make modifications to the design during the modelling as he, too, cannot always foresee all the three-dimensional effects of his design entirely in his mind's eye.

When the model is completed, another visit is paid to his client's works where a thorough examination is made of the model; and it is at this stage that the sales side are particularly concerned as it should be fairly safe to assume that when the model is in front of them, most of the production problems will have been foreseen and many of them solved. In other words, the design has reached that stage when it can be said that it can be made for the price, and all that is needed is the unqualified agreement of the men who will be responsible for selling it.

Having successfully passed this most important stage in the development I can arrange for the engineering drawings to be made and schedules to be prepared for production, during the preparation of which I keep a constant watch on the work. Many unforeseen problems can arise when detailing begins, and it is the Designer's responsibility to ensure that his design is closely followed in all respects. He must

**Original Direct on Contact Starter.**
Showing wholesale distribution of lettering and the eyebrow effect of the press button protective projections. The large corner radii are out of scale with the general proportion of the cover.



**Direct on Contact Starter designed for The British Thomson-Houston Co. Ltd.**
This design clearly illustrates the result of "cleaning up". All but the necessary information has been removed from the cover, and that which remains has been grouped neatly at the bottom. The projections, to protect the push buttons, have been integrated with the whole.

be constantly on the watch for the draughtsman's love of easy radii when a more subtle curve is intended. I know very well that it is much easier to show a number of radii than to draw a curve accurately and dimension by ordinates; but it must be remembered that when art comes into industry, outlines and sections are no longer arbitrary, but are the result of very careful visualisation by the Designer. For instance, radii are related to surfaces with meticulous care because they will control and position the highlights on the finished job. So reducing or increasing them can greatly detract from the eye appeal of the final product.

The workshop drawings, general arrangements and schedules having been handed to the client, the project is virtually completed; but the Designer must always be available and in close touch during the early stages of production to advise and assist when necessary. One hopes, however, that all will be well; and it should be if the team have done their job properly.

**Employment of a Consultant Designer**

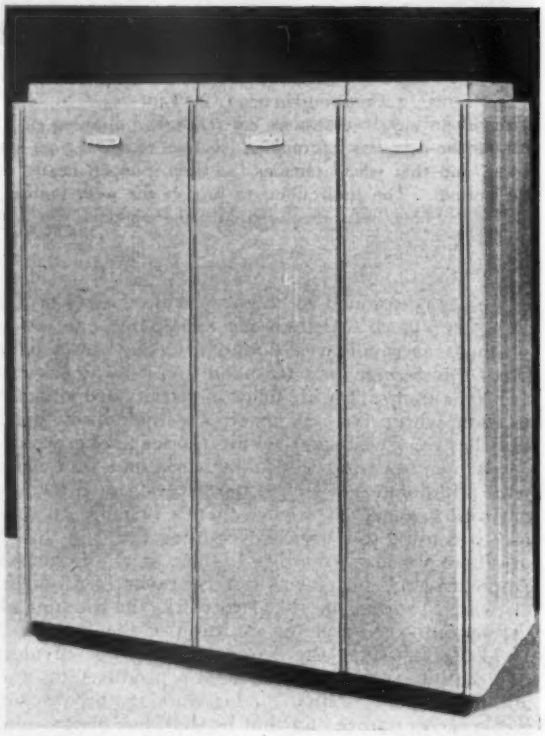
There is no accepted practice by which an exact fee can be established such as is the case in the architectural profession, where a fixed percentage is the recognised and accepted method of remuneration. This is occasioned by the very wide variety of the Designer's work which, in my experience, can cover products as small as a domestic electric plug to a giant transformer, or a teaspoon to a railway engine. It is true that such wide fields of activity are unlikely to come within the experience of a single individual; but they may well come within the scope of a group.

My own organisation usually works on a time basis with additional fees for the preparation of drawings or work engaged in on the client's behalf. In any case it is usual to receive a Retaining Fee.

Where we are "retained" there is a "Letter of Appointment" which sets out the range of products on which we may be asked to work, the amount of the retaining fee and the duration of the Contract. It also states that the Designer shall not divulge information regarding his client's products to unauthorised persons, that all his work in this respect is of a secret nature and that he shall not design in a similar field for any other manufacturer without the consent of his client, this prohibition also holding good for a stated period after the termination of his appointment as Consultant.

Additionally, we have certain clients for whom we have been operating for many years on a "fee for project" arrangement only. In these cases, also, the fee is established on a time taken basis and, naturally,

**The original type of Cubicle.**
Constructed from angle and sheet demanding a new design for each order with the need for drawing office time and the impossibility of stocking. Each order was virtually custom built.



**Control Gear Cubicle designed for the British Thomson-Houston Co. Ltd.**
The illustration demonstrates the flexibility of the modular system of construction, from standard sections, which allow numberless permutations covering all known requirements. This method also shows a great reduction in parts and makes stocking of components an easy matter.

similar professional ethics regarding clients' confidences are observed as in those instances where we are bound by the terms of a written agreement; but, of course, we are not so tightly bound in other directions.

**Conclusion**

In this Paper I have attempted to touch on as many aspects of the profession of Industrial Design as space will allow and tried to show Production Engineers that appearance design is no longer the spare-time activity of the artist or the architect but is, in fact, the full-time preoccupation of the specialist who has been trained from youth for his profession, who is in daily contact with all aspects of engineering, and who can understand the manufacturer's point of view.

I have tried, too, to impose upon you my conviction that the Industrial Design Consultant can bring new thoughts into those design offices where work has become channelled into a set course by decades of experience. He can take a leap in the dark which may, and often does, steer his client towards a new outlook.

Above all, I hope I have gone some little way towards making the point that by team work we can greatly enhance the prestige of our nation's merchandise. British industry at this moment is beginning to feel the effects of ever-increasing pressure from abroad, a pressure that can only be relieved by better and cheaper products which we, the Production Engineers and the Industrial Designers, can do so much to bring to fruition. Our combined roles provide a new hope for British industry.

**Acknowledgments**

Finally, I would like to place on record my sincere thanks to those of our clients whose names are appended to the illustrations herein, for their kindness in allowing me to publish these examples of my design work; and to certain of my colleagues for the editorial and other assistance that they have so freely given in the preparation of this Paper.

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**SESSION IX**

# INVESTING IN BETTER MACHINE TOOLS

by Sir STANLEY RAWSON

*Sir Stanley Rawson, Fellow of All Souls, Oxford, 1914-1921. Chairman, Wickman Limited. Vice-Chairman, John Brown & Co. Ltd. Director-General of Machine Tools, Ministry of Supply, 1951-1953. President of National Federation of Engineers' Tool Makers, 1949-1951 when he resigned to go to the Ministry of Supply. Co-opted to Council of N.F.E.T.M. October, 1953.*

**Sir Stanley Rawson**

INVESTMENT implies a return upon what is invested and that return must be more than what is needed to replace the amount invested, as well as what the late President Coolidge crisply called the "hire of the money". Quite a number of people are prepared to contend today that the return must cover what is needed to replace, by modern assets, those upon which the original investment has been spent. This — we may perhaps call it the "inflationary theory of redemption" — is really a by-product of excessive taxation. It reflects the growing uneasiness as to the amount and rate of capital accumulation in our economic system in which the number of compulsory preferred choices is increasing, so limiting gravely the proportion of accumulation available for free industrial expansion.

We are living in an age of metals. To all appearances we shall continue to do so for a very long time; and machine tools are the instruments by which not only metals but all similar products of art are given the shapes and forms in which we need them. The machine tool has come to be recognised, even perhaps

embarrassingly so, as the instrument of advanced production. It is thought of, especially perhaps in the House of Commons, as a mechanised cornucopia from which flows an increasing stream of desirable artifacts, shining new and self-sufficient. One day this may well be so; but for the present we should perhaps be content to say that the machine tool is a device by which applied skill can effect a geometrical and not an arithmetical improvement in production; improvement, of course, means more than quantitative improvement. The skill which can produce a good workpiece can produce the means of making many good workpieces, and making them speedily, accurately and consistently. Speed, accuracy and consistency or repeatability are the functions of machine tools and should not be merely the result of the manoeuvres of the operator.

In its present form, the machine tool is at once the creator and the creation of the most far-reaching and perhaps least regarded industrial revolutions of modern times, namely, the production as a matter of course of metals homogeneous and uniform in composition, and with known and predictable physical properties. Similarly cutting materials, as well as the materials to be cut, have reached a consistency of structure and performance which no longer leaves the machine tool designer or constructor to deal with the problem of irregularity in his materials of construction or in the cutting tools he uses. It is now possible to predict with confidence how a machine tool should run to remove most economically a given amount of metal. Production and production times can be planned with reasonable exactness and automatic cycles devised and determined, without fears of intermittent "hard spots" or similar irregularities. Ideal cutting speeds can be approached by the combination of well-designed cutting tools and well-designed structural elements of the machine tool.

**New Cutting Problems**

This does not, of course, mean that all problems have been solved. New metals, new artifacts, such as plastics, are coming into being, each presenting a new cutting problem, either in speed or tool form, or power absorbed. Reference need only be made to the variety and intensity of the design studies for producing, by machine methods, suitable blade forms for the gas turbine; and there is no doubt that problems of even greater complexity will be presented to us in the course of atomic power development; but the specialist development of today is the commonplace of perhaps ten years hence. Today we are more concerned with that which is the normal and accepted sphere. Seventeen years ago, it is probable that not more than fifteen per cent. of the machine tool population of the country could make effective use of hard metal tools. Today probably less than fifteen per cent. cannot. For many applications today the limit of cutting capacity of a hard metal tool is the strength of the bond between the tip and the shank; and new methods of attachment or application have been devised; and newer materials able to cut metal at fantastic speeds are already over the horizon.

Speed of cutting must be accompanied by accuracy; and the art of cutting must go hand in hand with the art of measurement. Pieces and components cut at high speeds must go together without that laborious and time-consuming rectification which can waste, on the fitting bench or floor, all that has been saved on machining. No small part of the irregularities of machine tool production came from intermittent shock in the mechanical transmission to the cutting tools. Improvements in gear design and gear production have gone far to eliminate this; and the substitution in many cases of hydraulic or electrical controls has removed still more of these sources of inaccuracy.

Machine tools are capital assets of a quite special type. They are especially flexible in that their use is not confined to one special field of engineering. It does not matter how specialised a particular machine may be, its products can find a home in a wide range of applications. This at once simplifies and at the same time complicates the problem of investment in them. More factually perhaps than any other form of capital asset, a machine tool can and should be valued as a calculable repository or store of valuable future services. What those services are must depend upon the particular product a machine has to produce and what are the means of calculating the probable intensity of loading of a machine; and whether the intensity of loading is enough to bring it about that the saving in labour cost can offset probably the higher oncost charges and higher depreciation cost.

If we look for a moment merely at the mathematical problem of direct labour cost, it would be profitable to refer to a short but very valuable study published in the early days of the war by the Machinery Publishing Company, Ltd. The author was Mr. E. G. Flushey, who evidently collected his data about 1939. Taking a comparison of three types of machines, he showed the wages cost per hour to be the figures in Column A; Column B shows the corresponding figures for 1956.

| | A<br>1939 | B<br>1956 | Increase |
|---|---|---|---|
| Capstan | 1/10½d. | 5/3d. | 180% |
| S.S. Auto | 8¼d. | 2/– | 182% |
| M.S. Auto | 1/2½d. | 3/– | 190% |

Comparing the current prices of corresponding machines, the position appears to be as follows :-

| | A<br>1939 | B<br>1956 |
|---|---|---|
| Capstan | 100 | 187.5 |
| S.S. Auto | 100 | 147.0 |
| M.S. Auto British | 100 | 132.0 |
| M.S. Auto U.S.A. | 100 | 164.5 |

Apart, therefore, from any problem of pace of depreciation, direct labour costs are swinging away from any reasonable conceptions of machine depreciation. In itself this is a *prima facie* case for replacement of more less effective by more effective machines.

**Depreciation**

Depreciation is, of course, a highly ambiguous conception. Technically, as opposed to financially, it means the process or series of processes by which a machine tool grows less valuable for its purpose. The stage of lessened value, at any particular point, may be marked subject to any abnormal influences, such as serious shortage or pressing demand for machine tools by its realisable market value. That market value is what the average prospective buyer thinks is the approximate worth of its future services in its then state. This is only an approximate guide, but is a useful check on financial depreciation or amortisation. The adoption, for technical purposes, of financial depreciation as an element of cost can lead to some curious misconceptions. How often have we met the case where estimates are given for work done or to be done on old machines apparently far below estimates for the same work on new plant, the whole difference arising from the mistaken idea that because a machine has been written down, its otherwise inefficient production cost is cheaper. Surely to the technical man depreciation is more akin to life assurance, the higher the age, the higher the risks of mortality or the weaknesses which lead to it. Today slow cutting is not good cutting ; and it is probable that in 80% of the work machines have to do, a sick or diseased machine will not do the work at all. In such cases the chief disability of a machine tool is "absence without leave". Unfortunately there are no "tables of mortality" for machine tools. People are not interested in machine tools in general but in machine tools in particular ; you cannot in such a varied and diverse population as machine tools get anything like the same "spread" as an Insurance Company has for its clients. On the other hand, there is much more uniformity of structure about a machine tool than about a human body and a much greater predictability of behaviour. If we take the life-expectation curve and reverse it, we could for, say, a 10-year life get a series approximately as follows :-

| | % | | % |
|---|---|---|---|
| Year 1. | 3.0 | Year 6. | 10.5 |
| Year 2. | 4.5 | Year 7. | 12.0 |
| Year 3. | 6.0 | Year 8. | 13.5 |
| Year 4. | 7.5 | Year 9. | 15.0 |
| Year 5. | 9.0 | Year 10. | 16.5 |

Such a series would be much more realistic and appropriate for cost and estimating purposes than to use as a yardstick of cost what is really nothing more than satisfaction with an imperfect recovery of expenditure. It is one more illustration of the fact that financial devices have no real significance for cost.

From a financial standpoint prudence would dictate that the recovery of investment should be as speedy as is practicable ; but financial convenience is a concept of a different order from that of engineering cost ; and this difference of aspect is often lost sight of when depreciation is considered as an element of cost. The early recovery of an investment is an application of earnings and not part of the cost of production on new machines.

**The Problem of Oncost**

Let us look for a moment at the problem of oncost, a subject upon which more has been written than perhaps on any subject, except politics and education. For the purpose of machine tool investment oncost may be described as the cost of having something, of housing and servicing it. In practice the difference in oncost between a slower running and a more efficient machine is that in the case of the latter, oncost is more obvious and determinate than in the case of the former ; but it is undoubtedly the case that the more speedy machines do need more careful planning of their output ; and may well be less flexible for some purposes than their multi-purpose predecessors. But it is highly probable that a detailed analysis of real direct and indirect costs would indicate that the difference may be easily exaggerated. Of course, where it is customary to recover oncost by a percentage charge on direct labour, a notable reduction in direct labour must appear at once as a large increase in the percentage needed to recover a given sum. But the given sum may well be less and not more.

Reference has already been made to the problems of probable intensity of demand upon a machine tool. We are apt to think of machine tools principally as machines of high productivity working at a considerable load factor on repetition work. These are far from being the only types of machines with which the investor has to concern himself. There exist today production machines whose capacity is so large that there is little likelihood, except under conditions of war or intensive temporary demand, that their output will even be absorbed. At the other end of the scale are machines for whose product the demand is in the nature of the case intermittent. In the case of the first class, commercial organisation has gone some way to concentrate and standardise demand. This is the case in the field of automobile components and in a good many electrical devices. Concentration of demand and standardisation of design have effected enormous economies in the field of repetition components ; and the machines themselves have similarly benefited. When we come to the "big fellows", the problem of idle time assumes considerable magnitude. Machine tool designers and makers in all important industrial countries have been faced with the problem of handling and shaping castings and forgings from the largest casts that can be made. In Great Britain the largest forging ingot that can be made today is about 250 tons weight. When some of the new plant now under construction is in service, this limit may well be exceeded ; and even more powerful machines will have to be available to handle the product. The multiplication of machines of this type is obviously uneconomic. They have to be designed to handle and to cut the peak weight and the peak dimensions to be handled. Not only the machines themselves, but the services they need — cranes, buildings, service pumps and motors — are

again on the same "peak" scale. It is obviously reasonable that commercial organisation should set about to procure that such machines are given the maximum possible work of their peculiar order, and that we should not suffer the economic waste, both of capital expenditure and skilled operation, which an unnecessary number of such machines would demand.

The economies in operation of large modern machines, on suitable work, are beyond question. Machinery times on integral armoured frames of tanks came down from weeks to hours by the use of large machines. We can look at the great vertical boring mills handling work up to 21 feet diameter without which the accurate machining of large slow speed generator casings or water turbines would be quite impossible. But these economies can be very dearly bought, unless sensible organisation can be applied to the building and use of these great machines.

One further consideration should be borne in mind. The introduction of the copying lathe and the profiling miller, with either built-in or detachable copying devices, has brought repetition machining to a point where quite a modest number of pieces justifies the use of copying methods, even where the pieces themselves are simple in outline. There are very few jobbing shops which would not find a copying attachment to a centre lathe the boon and the blessing to men ; and as these devices can work, either from a master piece or a template, their convenience and adaptability are excellent. Even where half-a-dozen pieces only are required at any one time, they can well pay for their keep.

Finally, perhaps we may touch upon one very difficult problem. Where does tooling leave off and a new machine begin ? With machine tools, as with every other form of mechanical extension of the human hand, there is a tendency on the part of the machine operator to expect new machines to do the work the way it has always been done and do it better. That is not the way to get the best out of a machine. Methods must suit machines. The psychological effect of the introduction of new machines can be completely lost if the new machines are asked to use just the same tooling set-up and the same work layout as the old. In that way the whole tempo of a shop can be lifted and the way opened to greater and probably more diverse output.

It would, perhaps, be helpful as a final point to draw attention to the efforts which are now being made upon an international scale to build up a unified conception of the significance and function of machine tool testing. It is, of course, a commonplace that in any articulated structure, minor irregularities in the constituent parts may well be compensated for in the finished and completed whole; and it is in the performance of the completed whole that the machine tool buyer is interested. This, I submit, is only half the story. You may not make a good machine out of exactly dimensioned parts, but your chances of doing so is far better than if you indulge in hit or miss construction. The experience of the leading members of the U.S. machine tool industry in meeting the demand of the automobile industry for consistent and accurate machinery has brought an immense improvement in the effectiveness and performance of their machines, and insistence upon accuracy in detail parts is the necessary preliminary to satisfactory wholes.

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**SESSION X**

# INVESTING IN BETTER QUALITY CONTROL AND INSPECTION

by Dr. BERNARD P. DUDDING, M.B.E., F.Inst.P.

*Dr. Bernard P. Dudding, Vice-Chairman, Advisory Scientific Panel, General Electric Company Limited. Apprenticed at Chatham Dockyard. Scholarship — Royal College of Science, Double First Diploma, Physics and Engineering.* 1911 - 1915 — *National Physical Laboratory.* 1916 — *Assisted in founding Research Laboratory for the General Electric Company. President, International Commission of Glass. Awarded M.B.E. for Scientific Services in the First World War.*

BY reference to the Conference Programme, you will note that the titles for all the addresses have a common form. It is clear that those who have been honoured by the invitation to address the Conference had little influence on the choice of the titles of their addresses. As I would have preferred a rather different emphasis in the title of this address, I wish first to analyse the title in some detail.

*Investing.* The first word suggests that I have to arouse your interest in an 'investment'. Normally when one thinks of 'investing', two thoughts immediately arise: the act of investing calls for

expenditure, and the question then arises "how much shall be invested?" The decision taken will be largely influenced by the return which is likely to accrue as a result of the investment.

I shall not refer to this aspect of the subject allotted to me except to say that in a very long experience extending now over nearly 30 years, I have never found it necessary to ask for expenditures amounting to as much as £20 when interesting persons in methods which aim at making better use of the inspection normally carried out in an industry. Any expenditure finally incurred has been incurred voluntarily, presumably because of economies effected.

With regard to the return which has accrued as a result of introducing new principles to govern the use of inspection data, it is not appropriate for me to make any financial estimate. In order to do so with any reasonable degree of accuracy it would be desirable to collect data from a number of pairs of manufacturing organisations, the members of each pair being similarly manned and equipped and concerned with the production of similar goods, but in one of which the older methods of inspection were retained whilst in the other new concepts have been grafted on to the inspection procedures.

To those interested in obtaining a rather more definite indication of the value of the methods, to which I will direct your attention later in this Paper, I would refer you to contributions made by responsible persons in industries other than my own whom it has been my privilege to assist during recent years. (See Item 1 in Appendix.) There may be some present who have had sufficient experience of the methods often referred to as "Statistical Quality Control", who will stimulate discussion by referring to both discouraging and encouraging episodes in their experience. In the course of the Paper I will underline those aspects of my subject which my own experience would suggest are of importance. Further, I will try to indicate how the proper use of inspection data helps to stimulate research, better utilisation of facilities, better production planning, simplification and standardisation of procedures and — even more important — assists in creating interest in quite dull routine production activities and promotes better relations between persons performing different functions in an industrial organisation.

*Better Quality Control.* What do the words "Quality Control" convey? The control of the quality of the goods produced has always played a part in the activities of manufacturing organisations. The century-old practice of inspection is evidence that manufacturers have felt it necessary to maintain the quality of their goods above some standard. The maintenance of quality demands correct action by persons carrying the responsibility of maintaining plant and processes in a satisfactory condition. The introduction of the word "statistical" does not reduce the importance of taking action. However, it is true that the appreciation of statistical principles does assist in the presentation of the results of inspection in a form readily appreciated and the study of the results, following the same principles, does give guidance in the deployment of the inspection effort and indicates where, when and how much inspection should be carried out. It is very important to emphasise that unless the presentation of the results of inspection in the form of control charts stimulates early and correct action, then the introduction of "Statistical Quality Control" will effect little improvement in the efficiency of a manufacturing procedure.

*Better Inspection.* To complete consideration of the title attached to this session of the Conference, I offer the following comments on "Better Inspection". I suggest that this phrase does not mean 'more accurate inspection' or 'more inspection'. In my experience, unnecessarily high accuracy in inspection is used nearly as often as too low an accuracy and certainly too much effort is very frequently spent on inspection because the procedures adopted do not extract the maximum amount of information from the results of inspection. In my view, the emphasis should be on 'better use of inspection data' and on this aspect of a very large subject I propose to concentrate attention in this Paper.

*Value of Papers.* Before concluding this introduction, I think it appropriate to suggest that the organisers of this Conference made a mistake when inviting me to prepare this Paper. There is ample evidence that the time that I, sometimes in association with junior colleagues, have voluntarily devoted to the preparation of two handbooks, nearly 50 Papers for various institutions and over 500 lectures to students at universities, technical colleges, to institutions for inspectors, production and other engineers, members of the Institution of Industrial Administration and its local branches, has had little effect. Of this I became gradually aware between the time when I presented my first Paper to the Institution of Engineering Inspection in January, 1926, and before the outbreak of War. Of course, I have followed the usual procedure of not accepting the full responsibility for this lack of success and have been guilty of what I hope has not been an unduly discreditable example of 'passing the buck'. I have consistently emphasised that the application of statistical principles to industrial problems is a technique and like all techniques is acquired only by action, preferably guided by a coach, under practical conditions. (See Item 2 in Appendix.) It is a technique which demands detailed acquaintance with the industrial problem and the associated fundamental knowledge relevant to the problem as well as an appreciation of the statistical concepts involved in the collection, presentation and study of data. That the presentation of Papers and lectures has not failed completely has been due to the occasions when someone has been sufficiently stimulated to attempt to apply the principles outlined in the Papers and lectures and has sought a little help in the initial stages of their work.

## Presentation and Study of the Results of Inspection

No attempt is made in this Paper to describe the procedures which are commonly referred to as "Quality Control". Ample literature is available to which reference can be made and Items 3 to 6

given in the Appendix will be found to be adequate as an introduction to the technique.

In the following brief notes, examples will be described which have come to my notice at or after meetings where a member of the audience has expressed doubt as to the necessity for improving the presentation and study of data, but has been co-operative enough to provide data and opportunities for discussing them.

The processes will not be described or the nature of the industry closely defined, because such knowledge too readily provokes those who are satisfied that no change in their methods is necessary or who fear they will meet insurmountable difficulties to take refuge behind excuses such as: "clearly that factory was inefficient and any reasonable change would have improved it", or "in the example cited the application of the methods was obviously straightforward and did not present the difficulties inherent in my particular production".

**Practical Examples to Illustrate Information Gained by Good Presentation and Study of the Results of Inspection**

*(i) Machine shop example.* This example is given because it will serve to illustrate how plotting the results of routine inspection of samples sometimes reveals loss of effort in the operation of semi-automatic and automatic machines and indicates the presence of irregularities needing investigation.

In the example, two sets of eight pieces were produced as a group at one time by two tools mounted tandem fashion. In the exploratory stage a sample of five was chosen from each group of eight. The results for articles made by the same tool are indicated by the same sign on the charts illustrated in Fig. 1.

The average range in the results for a sample of five was 0.46 of 0.001". The total tolerance was 0.002", hence the Relative Precision Index $=2/0.46=4.35$ and the machine is capable of making all product within tolerance, and modified control limits for the averages can be used. (See Tables 4 and 5 of B.S. 2564.) The 1 in 40 limits are shown by a broken line on both the charts. The upper 1 in 1,000 limit is shown on the range chart but not the lower limit, which is less than 0.0001". The limits 1 in 40 and 1 in 1,000 for average are so close together that only the 1 in 40 limits are shown.

It will be noted that there is evidence that the range is sometimes rather high, and this was being investigated. The suggestion was made that it was due to hard spots in the steel being worked, or to soft spots in tools.

The average chart for the 17th demonstrates a condition frequently encountered.

Following the normal practice of taking particular care to avoid the production of scrap, it will be noted that the tool setter did not take full advantage of the tolerances allowed. This was likely to involve more

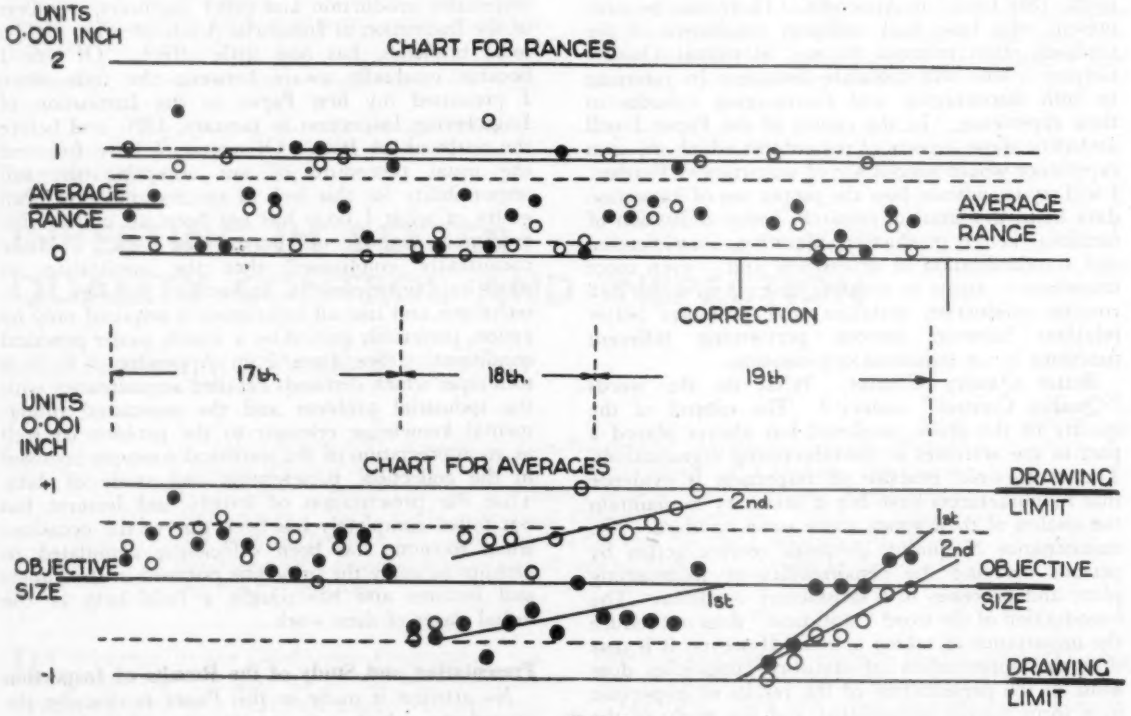



FIG. 1.
CONTROL CHARTS FOR SAMPLES OF FIVE

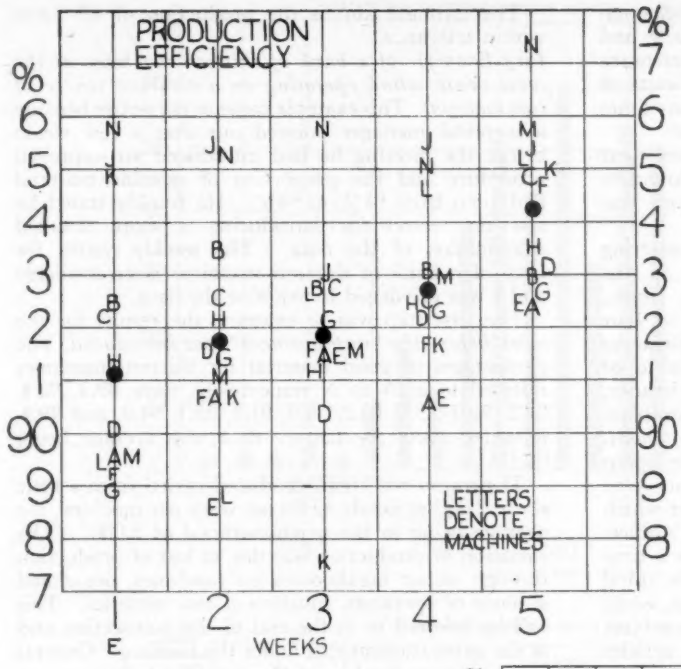



Fig. 2(a).

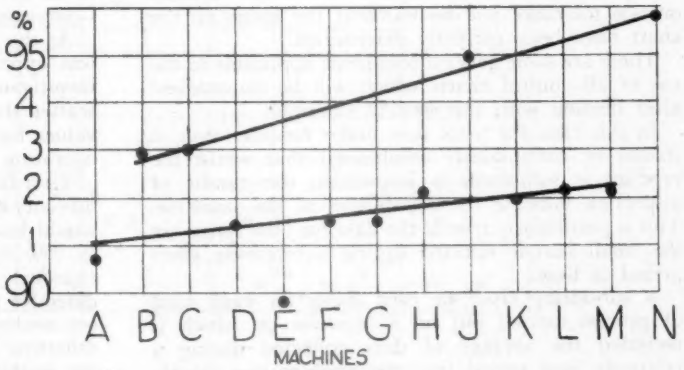



Fig. 2(b).

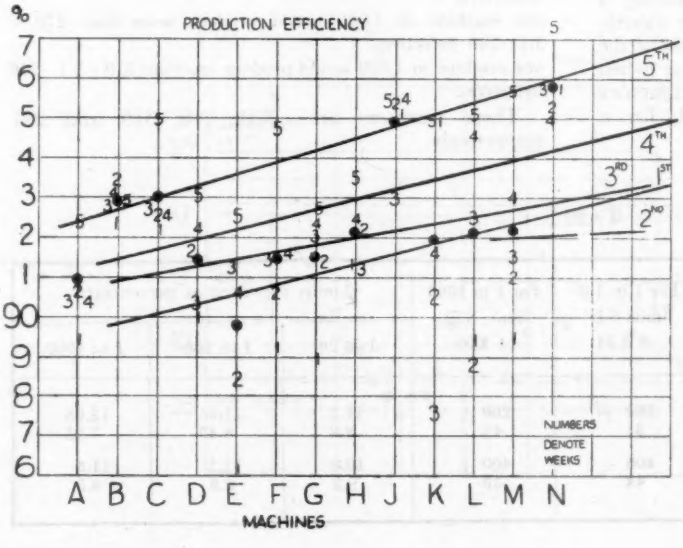



Fig. 2(c).

work in tool setting and some loss of production while the too frequent adjustments were made and the production of some articles outside tolerance revealed by subsequent inspection, involving waste of effort in attempting correction, which is sometimes associated with scrap made during correction.

It will also be noted that changes due to tool wear appeared on the 18th and 19th. This was found to be due to a new batch of cutting tools, and was immediately remedied.

This example provides an opportunity of referring to a difficulty nearly always encountered in the machine shop when introducing control charts. Because the limits for the average of two to four measurements must fall within the official tolerances for individual items if the process is capable of producing 100% of the product within tolerance, those closely associated with the machine complain that control charts *rob them of the tolerance allowed.* This situation demands attention and time spent in removing this misapprehension is well spent. One method of doing so is to create an experiment which can be carried out in the canteen or inspector's office. Another is to permit a machine to operate for a time with the average values scattered about the usual 1 in 20 or 1 in 40 upper value on the chart while some 200 to 500 pieces are made, and then to subject this product to 100% inspection. A few articles outside tolerance will be found if the limits on the chart have been correctly determined.

There are some general comments applicable to the use of all control charts which will be summarised after dealing with the specific examples.

In this class for work now under consideration, it should be continuously emphasised that whilst the product is subjected to inspection, the results of inspection indicate the capabilities of the machine. This is particularly true of the data for ' the range ' in the small sample selected during a relatively short period of time.

A subsidiary chart or card index for each kind of process carried out on a machine on which is recorded the average of data collected during a relatively long period (say one week to one month) gives information as to the rate of deterioration of the machine. This data is also of great value when planning production because the use of unsatisfactory machines, or machines unnecessarily good, for a particular task can be avoided.

The ultimate aim is the production of all items within tolerance.

***(ii)*** *Example of a bank of thirteen machines of the same construction operating on a common source of raw material.* This example came to my notice because a sceptical manager pointed out that a few weeks before the meeting he had introduced an improved procedure and the proportion of saleable material had risen from 91% to 94%. He frankly stated he saw no reason for introducing a more detailed examination of the data. The weekly results for each of a bank of thirteen machines were available and I was privileged to examine the data.

The first step was to examine the results for the *week before the ' improvement ' was introduced.* The percentages of good material for thirteen machines referred to as A to N respectively, were 89.5, 92.4, 92.2, 90.0, 85.9, 89.2, 88.9, 91.3, 95.1, 94.8, and 89.4, in order along the factory floor, the average being 91.1%.

The number of items produced varied from a little above 2,000 to nearly 4,000 per week per machine, the average being in the neighbourhood of 3,000. (The variation in production was due to loss of production through minor breakdowns on machines, occasional absence of operators, insufficient raw material. This will be referred to at the end of this sub-section and in the general comments under the heading " General Comments on the Use of Control Charts ".)

As the general average loss per machine per week was approximately 9% of 3,000=270 in the week investigated, the first step taken was to estimate the scatter that would be expected in the performance values for a very large number of similar machines operating on raw material of the same characteristics.

To a first approximation, theory indicates that the diversity of the results for this large bank of machines would have a standard deviation of $\sqrt{}$ (3,000 × .91 × .09) = $\sqrt{}$ 246, i.e. one machine in 40 would be expected to produce more than $270 + 2\sqrt{246}$ defective pieces. Similarly,

one machine in 40 would produce less than $270 - 2\sqrt{246}$ defectives.

one machine in 1,000 would produce more than $270 + 3.1\sqrt{246}$ defectives.

one machine in 1,000 would produce less than $270 - 3.1\sqrt{246}$ defectives.

These numbers are: 300, 240, 319 and 221 respectively.

TABLE 1

| Production | S.D. of no. defective | For 1 in 20 limits S.D. × 1.65 | For 1 in 100 limits S.D. × 2.33 | For 1 in 1000 limits S.D. × 3.09 | Limits expressed as percentage. | | |
|---|---|---|---|---|---|---|---|
| | | | | | 1 in 20 | 1 in 100 | 1 in 1000 |
| 2000 | $\sqrt{}$ 180 | 200 ± 22 | 200 ± 31 | 200 ± 41 | 11.1<br>8.9 | 11.55<br>8.45 | 12.05<br>7.95 |
| 4000 | $\sqrt{}$ 360 | 400 ± 31 | 400 ± 44 | 400 ± 59 | 10.8<br>9.2 | 11.1<br>8.9 | 11.5<br>8.5 |

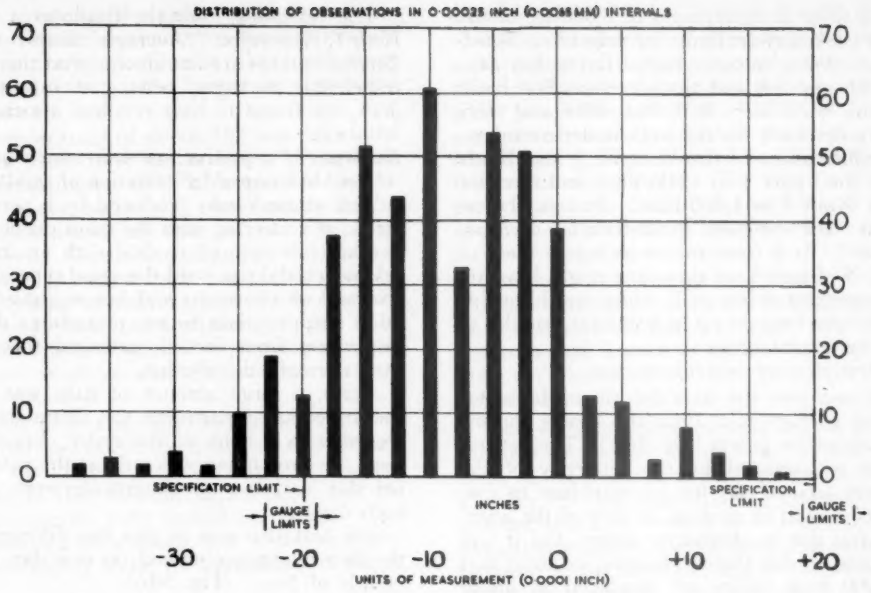



Fig. 3(a).

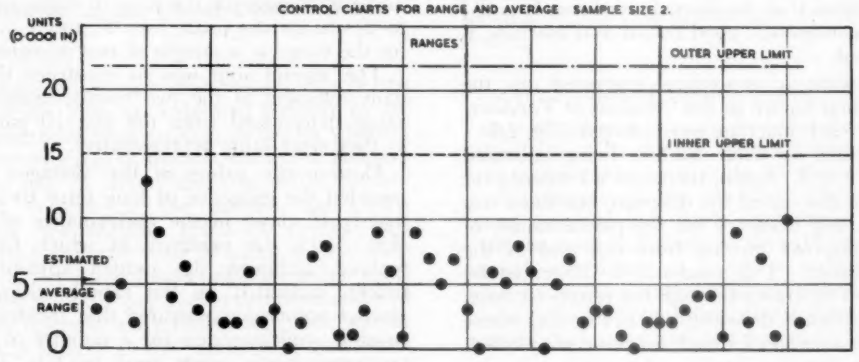



Fig. 3(b).

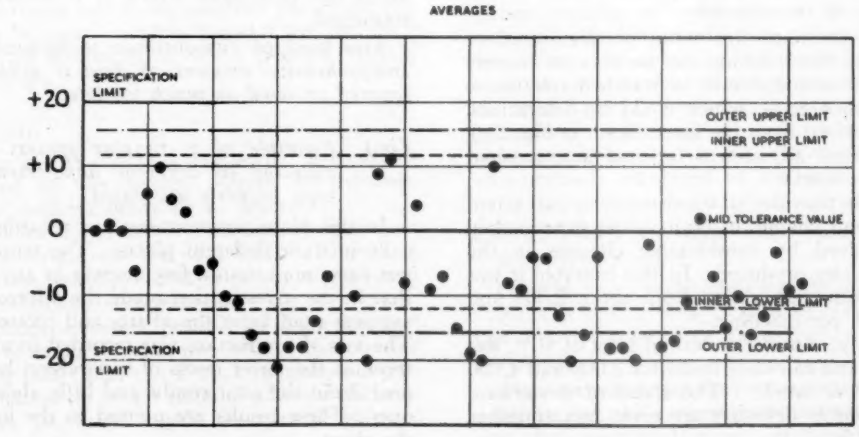



Fig. 3(c).

Expressing these as percentages of 3,000 we obtain approximate control chart limits for defectives. Reading from outer lower to outer higher limits they are: 10.0, 8.0, 10.6 and 7.4 and the corresponding limits for proportion good are: 90.0, 92.0, 89.4 and 92.6.

It will be noted that, for the week under consideration, the performances of machines N, J and K are much above the upper 1 in 1,000 limit and machine E below the lower 1 in 1,000 limit. In fact, the results for that week indicated a considerable diversity in performance. It is clear that a technical study of machines E, N, J and K at that time might have revealed an important defect in E which would enable all machines to be brought up to a standard similar to that of the better machines.

*This is the first piece of new information*

As a next step plot the data for all machines for five weeks on a chart indicating the results for the different machines by letters (Fig. 2(a)). The general improvement is indicated by the tendency of the average values (shown ●) for all machines to rise. This tendency should be studied, in view of the assertion that it was due to deliberate action, but it will not be discussed in this Paper. Bearing in mind that the 1 in 1,000 limit values are displaced by about 1.5 units % from the weekly averages it will be noted the chart confirms that, in general, machines N and J have yielded consistently good results and machine E consistently bad.

Next, following a procedure suggested by the statistical method known as the 'Analysis of Variance' the results for each machine were plotted (Fig. 2(b)), the weekly results for each machine being indicated by the figures 1 to 5. Again, there was a tendency for the 5's to be at the top of the diagram, but there was also a very strong tendency for the performances of machines to improve passing from one end of the factory to another. This tendency is illustrated by the lines of best fit drawn through the results for each week and more clearly demonstrated in Fig. 2(c) where the five weekly averages for each machine are plotted. (The diversity between groups of machines is also confirmed).

***(iii)*** *This is a second new piece of information worthy of investigation.*

Should the cause of this trend be discovered or if it be decided that nothing can be done to remove it, then each machine should be watched relative to limits appropriate to it, which could be determined from values derived from the lines drawn in Fig. 2(c), making any small adjustment for real improvement during the five weeks.

This example provides an opportunity to call attention to the small change in limit values expressed in units % involved by considerable changes in the number of articles produced. In this example it was stated that production varied from about 2,000 and 4,000 per week per machine.

For simplicity, consider a normal level of 10% loss of production and calculate limits for 2,000 and 4,000 per hour, day or week. (The standard deviations, S.D, of the number defective are given by $\sqrt{}$(number produced) $\times$ .9 $\times$ .1).

The foregoing example illustrates a statement in Item 1, Appendix, " 'Averages' thrown up from production batches are not always what they seem. Many respectable averages, when put into the statistical dock, are found to have criminal associates ".

*Example of a production unit which gave rise to a 'double-humped' distribution of results.* (*Fig.* 3(a).)

This example was produced by a person who had attended a meeting with the main purpose of demonstrating that he had to deal with an industrial process which did not yield the usual type of distribution (Normal or Gaussian) and hence argued that it was quite inappropriate to use procedures deriving their inspiration from formal statistical theory based on the 'normal' distribution.

Again, a large amount of data was available in the inspection department and fortunately they were recorded in a book in the order obtained. In this case, the production was only at the rate of 20 to 40 per day and two measurements were available for each day.

The first step was to plot the differences between the two readings obtained on one day; (range in a sample of two). (Fig. 3(b).)

It was obvious that there was reasonable stability and the average of the first 10 differences was used to determine the usual 1 in 40 and 1 in 1,000 limits for the range in a sample of two measurements.

The second step was to construct the chart for daily averages of the two results, using the average range determined from the first 10 pairs of results as they were quite representative.

Plotting the values of the averages immediately revealed the existence of long term trends (approximately 10 days) in the performance of the process (Fig. 3(c)), the existence of which had not been realised, although the sudden adjustment to the process indicated by the rapidly rising groups of plotted points demonstrated that incidents, probably causing unpleasantness for a number of people, had promoted drastic action much too late. The chart for average if available, should have (not necessarily " would have ") stimulated action earlier enough to avoid the difficulties which it is evident were encountered.

This kind of circumstance is frequently met: *a comprehensive amount of data is available but is ignored or acted on much too late.*

***(iv)*** *Example of a complex process where data collected in different departments had not been properly associated.*

In this plant temperatures are recorded automatically in three different places. The temperatures do not vary more than a few degrees in any one day, so that in the investigation made the approximate average was read from the charts and plotted. (Fig. 4). The loss of production was recorded in an office, but those at the lower levels of supervision heard a good deal about the poor results and little about the better ones. These results are plotted in the lower part of the chart.

Again, it is clear that the yield varied appreciably in spite of the relative constancy of the temperature at two places on the plant. On the other hand, there were long period drifts in the temperature recorded at the third place.

A fall in temperature of about 10° was associated with relatively small increases in losses. Periods of stability of temperature were accompanied by an improvement in the results. A small steady rise in temperature was associated with a relatively large rise in the losses. Needless to say, directly this was revealed a plausible reason for it was put forward by the technical people concerned, but whether or not that was correct or has since been demonstrated to be valid, I do not know. *Plausible explanations should be received with suspicion and some attempt made to establish their validity.*

This example illustrates how the public exhibition of a simple chart on which the available daily results were plotted would have stimulated interest among those working in the different departments and indicated where special care should be taken. The question of limits hardly arises, but could be determined from the scatter about the lines drawn in Fig. 4.

## General Comments on the Use of Control Charts

*Exhibition of charts*

The greatest contribution that control charts can make is lost unless they are exhibited publicly in the factory. There have been striking examples where a very great improvement in the efficiency of a division, and subsequently in other divisions, of a factory has resulted because of the interest the charts have aroused, the friendly spirit of rivalry they have stimulated and the sense of achievement they have provided. It is my conviction that unless some incentive other than the pay packet can be introduced where routine operations are concerned, there will always be lack of interest in the process and dissatisfaction among the operators involving a loss of efficiency in production.

Further, persons in charge of operations and departments through which the product passes are encouraged to be more co-operative and the tendency to attribute all difficulties to others reduced, with a gain in efficiency.

*Notes on charts*

The value of the charts is augmented if incidents are indicated on the charts, possibly by symbols. Examples of such incidents are as follows:
a shut-down for minor repairs; change of operative; change of material (note the nature of the change, if known); action taken to deal with some untoward event not frequently encountered.

An independent record, possibly in chart form, of the nature of minor breakdowns and of the number of operating hours between similar breakdowns provides information on which rational schemes of maintenance can be based, with an overall gain in efficiency.

*Need for periodic survey of inspection procedures*

Whilst the principles governing the use of a so-called 'statistical quality control' system are applicable to all kinds of processes, there can be no ready-made procedure suited to all kinds of production or even suited to all occasions in the same organization. Much skill and ingenuity can be exercised in planning the procedures adopted. The changes stimulated by the use of control chart techniques will demand revision of the procedures from time to time if the full value of the progress achieved is to be extracted.

Circumstances have been encountered where a procedure introduced to meet conditions at some time in the past has continued long after it was necessary and sometimes until those nearest the work did not know why the procedure had been introduced.

The establishment of a high degree of stability in the performance of a machine or process resulting from the full use of available information collected as part of the inspection procedure, enables the amount of routine testing to be reduced. When such reduction is contemplated, careful consideration must be given to the technical and economic consequences of failure to detect a change. Such a reduction in inspection always involves a return to increased inspection at the first sign of any deterioration in the results.

*Educative value of control charts*

It is not always fully realised that if statistical techniques are to be readily accepted in an organization and action taken as a result of special work of the kind indicated in the next paragraph, then supervisors at quite low levels must become acquainted with the statistical mode of thought and have gained enough confidence in statistical methods to support wholeheartedly action promoted by statistical studies. Familiarity with, and discussions of, results shown on control charts provides the necessary training.

*Additional uses of control chart data*

The data recorded on the charts maintained in various sections of a factory can be studied using more advanced methods. (See Items 7, 8 and 9 Appendix). Their study will sometimes reveal the need for information involving research, or indicate the need for a planned experiment carried out under production conditions. If such experiments are to yield reliable results, the unbiased co-operation of persons normally employed on the work is necessary.

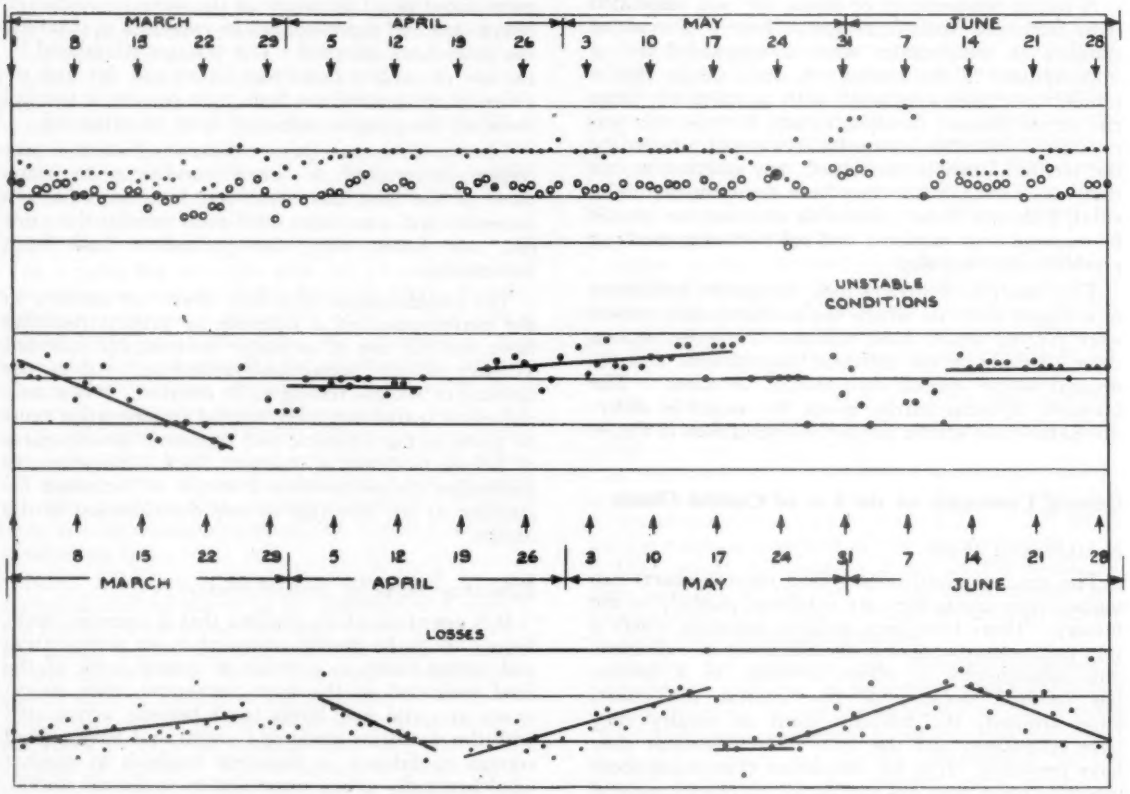
*Control charts for data other than those relating directly to products*

Control chart techniques can be applied to such matters as typing errors, errors of computation, time lost due to casual abstentions from work, cost data, and so on.

They have been applied to estimated sales data in order to give the earliest possible warning if production plans need modification in the light of events.

FIG 4

RECORDED TEMPERATURES
AND LOSSES FOR POOR QUALITY




## APPENDIX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# INVESTING IN SIMPLIFICATION AND STANDARDISATION

by Professor HAROLD W. MARTIN

Professor Martin

*Professor Martin was born in London and educated at Manchester College of Technology, Boston, and North Eastern Universities and Massachusetts Institute of Technology.*

*He served an apprenticeship with Metropolitan-Vickers Electrical Company Ltd. and, since his graduation from Manchester College of Technology in electrical engineering in 1926, has been successively design engineer, sales engineer, technical editor, industrial engineer, management consultant and teacher.*

*Since 1947 he has been in charge of production engineering in the management engineering department of Rensselaer Polytechnic Institute, Troy, New York, where he is Professor of Management Engineering.*

*Professor Martin has authored many articles on electrical and management engineering subjects, most recently in the fields of statistical work measurement, simplification and standardisation and automation. He is a member of the Society for Advancement of Management, the American Society for Engineering Education, the Operations Research Society of America and is a Past-President of the Work Simplification Society in Boston, Massachusetts.*

*He is at present on leave from Rensselaer Polytechnic Institute to serve as consultant to the European Productivity Agency in connection with a programme of lectures, conferences and training courses in simplification, standardisation and variety reduction, being given in various European countries.*

PRODUCTIVITY is the key to increased earnings in an industrial economy. This is true for the population of a nation; for the stock-holders, executives or workers of an industrial plant; or for the owners or clerks in a sales organisation.

When more products are produced by a given manufacturing staff and their facilities, productivity is increased. More products are created for the same production cost and the average cost per unit product is reduced.

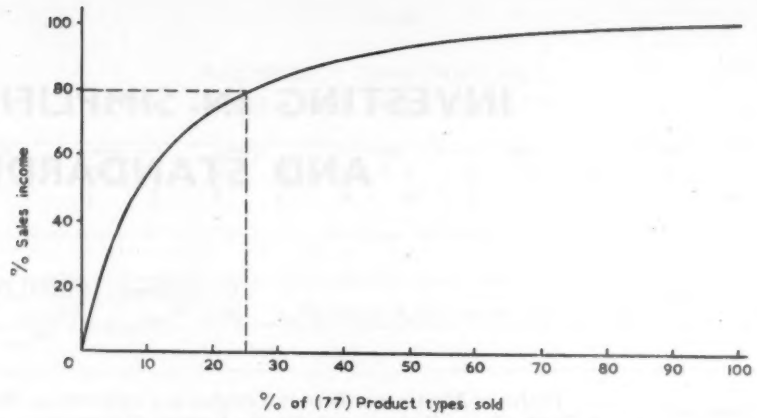
If the reduction in manufacturing cost induces lower sales prices, the customer's willingness to buy is increased and the existing sales staff can sell more products. The increased sales productivity thereby realised reduces the average selling cost per product sold. This is perhaps the clearest example of how productivity can be increased by making things easier. Because the customer is more willing to buy, the selling process is simplified.

Simplification is the key to such cost reductions through increased productivity. Simplification of each product; simplification of the processes by which products are designed and manufactured; simplification of the range of products offered for sale; simplification of the distribution and selling processes.

## I.—SIMPLIFICATION IN SELLING

### 1. Willingness to buy

*The customer's willingness to buy is the key to sales productivity.* Usefulness, quality, attractiveness of appearance, as well as price, all affect this vital willingness to buy. Sales simplification has, therefore, to be based on the most accurate information economically available which reveals the relative willingness of the average customer to buy each of the products offered for sale. There are several methods by which customer willingness to buy may be revealed.

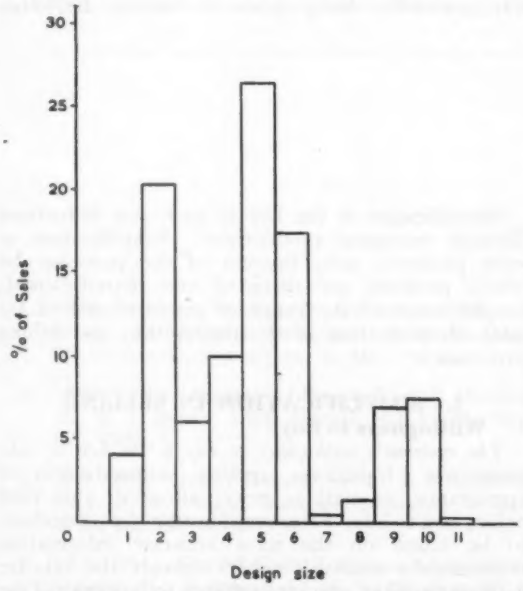



Commercial Refrigerator Cumulative Sales Distribution-1955

Figure 1

It is surprising how often major sales decisions are made without the help of such information.

One of the easiest ways to reveal the relative willingness of customers to buy is to analyse sales records already available. Such analysis frequently shows that a minority of the products sold produces a major part of the sales income. A representative cumulative distribution characteristic for the 1955 sales of a small commercial refrigerator concern is shown in Fig. 1. *It shows* 25% *of the* 77 *products sold accounting for* 80% *of the sales income.* Isolated cases have shown 10% of the products providing 95% of the sales income. The same sales statistics are also presented in distribution diagram form by design sizes, in Fig. 2. This diagram is a combination of three statistical populations: sizes 1, 2 and 3 centred around 2; sizes 4, 5, 6 and 7 of which 5 is the mode; and sizes 8, 9, 10 and 11 of which 10 is the mode.




Distribution of 1955 Sales of Commercial Refrigerators

Figure 2

Such data unquestionably reveals that customer willingness to buy is largely centred on relatively few of the products offered for sale. The logical question raised by this revelation is to what extent selling efforts should be concentrated on the popular minority of products by elimination of the unpopular majority, so as to increase sales productivity and lower sales costs. The answer to this question has to be approached with considerable caution. The popularity of some products may be due to their being sold at unprofitably low prices. *Analysis of sales by profit per product is therefore essential.*

## 2. Profit by Product

While statistics for sales income per product are usually readily available, the profit earned by each product sold frequently is not. The true profitability of each product depends on the price at which it is sold as compared with the total cost of manufacturing or procuring the product, of stocking it in anticipation of sales demand, and of selling it.

In a purely sales organisation, the procurement cost of each product is usually known. In a manufacturing and sales organisation, the manufacturing (plus materials procurement) cost for each product is more difficult to obtain, because a multiplicity of materials and components contribute their quotas of cost to the total. Analysis of such costs by products is, therefore, frequently dispensed with in the interest of accounting economy and only the total costs of groups of similar products or of all products sold are computed.

The costs of stocking products in anticipation of sale tend to be lower per popular product than for unpopular ones, because popular products sell more quickly and are in stock incurring storage costs for a shorter time than the unpopular ones. In like manner, the costs of selling popular products tend to be lower than for unpopular products, because their popularity

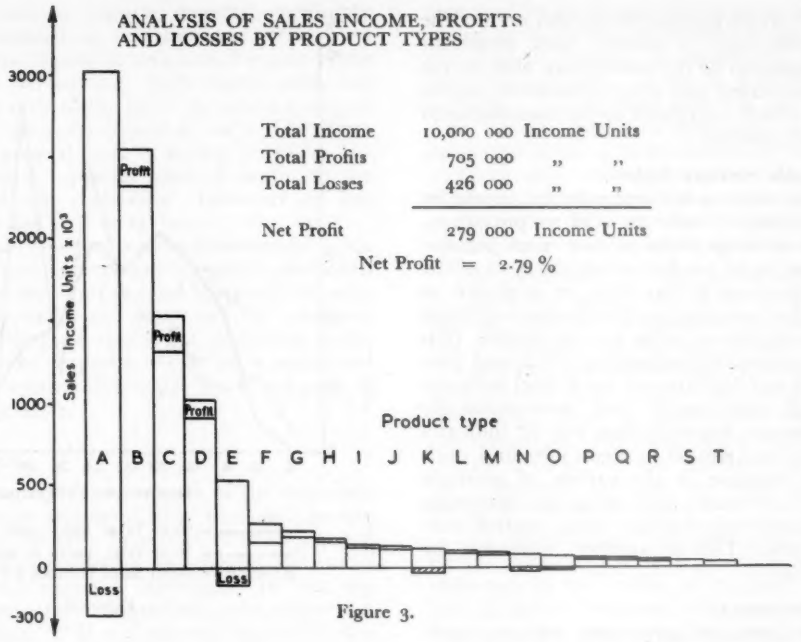

ANALYSIS OF SALES INCOME, PROFITS
AND LOSSES BY PRODUCT TYPES
Total Income 10,000 000 Income Units
Total Profits 705 000 " "
Total Losses 426 000 " "
Net Profit 279 000 Income Units
Net Profit = 2.79 %
Sales Income Units x 10³
3000
2000
1000
500
0
-300
Profit
Loss
Product type
A B C D E F G H I J K L M N O P Q R S T

Figure 3.

makes them easier to sell and less sales staff time and cost is spent in accomplishing their sale. These inferences, though logically valid, are difficult to confirm.

In the representative case, such stock and sales costs are lumped together and apportioned to the product costs in proportion to the sales income value of each product on the familiar percentage overhead basis. However, statistical sampling techniques are available by which the variations in these costs as between popular and unpopular products, may be determined economically and apportioned more equitably.

In particular cases, product profit analyses of the type shown in Figs. 3 and 4 may show that the minority of the products which account for the majority of the sales income do not account for as large a portion of the sales profit because of the low

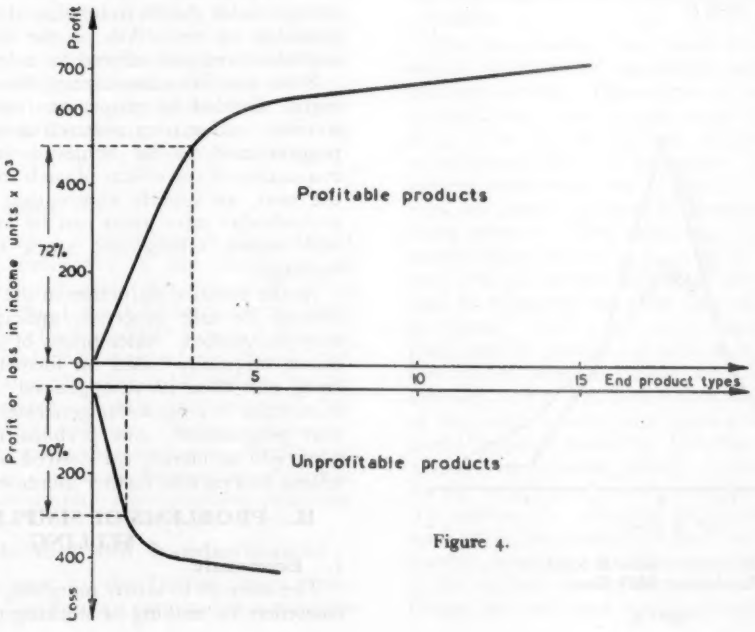



Figure 4.

profitability of certain popular items, and even of the absence of profitability of others. Such situations call for a re-appraisal of the sales prices and, in the case of a manufacturing and sales organisation, of the various factors which contribute to the manufactured cost of each such product.

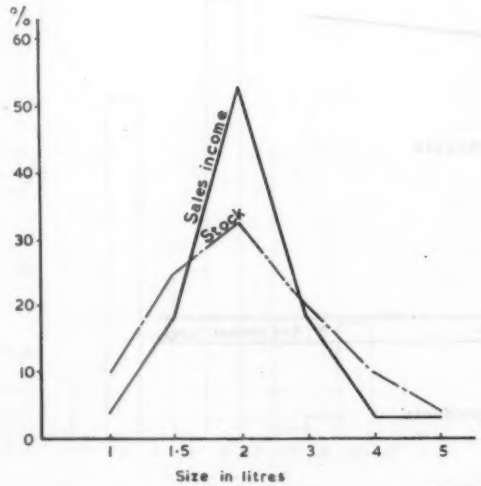
### 3. Stock Levels versus Sales

Analysis of the relation between sales and stocks for each product is also of value in sales simplification. Frequently the average stock of the most popular products is found to be too low, while the stock of the least popular products is too high, as is shown in Fig. 5.* A too low average stock indicates a perhaps uneconomic tendency to order too frequently, plus a danger of occasionally exhausting stock and preventing sales. A too high average stock level indicates working capital unnecessarily and uneconomically tied up in a slow-moving stock item. Fig. 6* indicates that such lack of correlation between sales and stock levels tends to increase as the variety of products offered for sale increases, indicating an increasing and costly difficulty of economic stock control with increasing variety. This is another argument for sales simplification.

### 4. Market Research

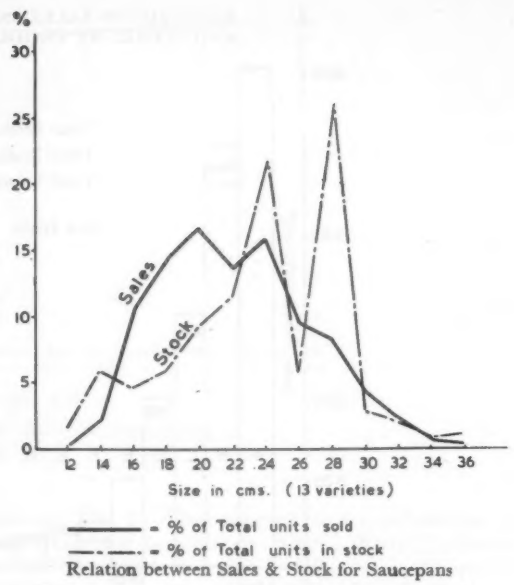
Additional information concerning customer preferences with respect to sales aspects such as appearance, style, colour and price, can be obtained by the use of the statistical opinion sampling methods of market research. Great care has to be taken, however, to ensure that the samples taken are properly weighted so as to reflect accurately the complexion of the actual customer population. Otherwise the results obtained from the opinion sampling may not be truly representative and therefore dangerously misleading. In the final analysis, except with respect to completely new products, market opinion sampling research should be used as a supplement to, rather than a substitute for, the analysis of sales statistics in determining bases for sales simplification through reduction in the variety of products offered for sale.

* See Bibliography, Item 9.




Relation between Sales & Stock for Aluminium Milk Cans.

Figure 5.




Relation between Sales & Stock for Saucepans

Figure 6

### 5. The Simplification Programme

It will be apparent from the foregoing that in increasing sales productivity through sales simplification, *there is no substitute for accurate and detailed sales, stock and profit data.* The analyses of such data provide indispensable guides to intelligent product assortment planning or reduction in the variety of products manufactured and offered for sale.

Sales simplification cannot be accomplished overnight. Guided by proper analyses of accurate sales statistics and market research data, and deliberately programmed to be achieved step by step with evaluation of the effects of each step before initiating the next, an orderly elimination of unpopular and unprofitable sales items can be accomplished which will reduce selling and stock costs and increase earnings.

As the planned reduction in the variety of products offered for sale proceeds, anticipated cost savings may be verified. Sales prices of the remaining products, originally based on former selling and stock costs, can then be re-appraised in the light of the reductions in costs so far generated by the simplification programme, and perhaps reduced. This, in turn, will accelerate the desired simplification of the selling process and further increase sales productivity.

## II.—PROBLEMS OF SIMPLIFICATION IN SELLING

### 1. Economic

The attempt to satisfy marginal, non-representative customers by making or stocking products they need

but which are not in popular demand, inevitably reduces sales productivity and increases selling and stock costs. In the representative case, because of the complexities of accounting, these extra costs are apportioned not only to the products which generate them, but to all products offered for sale. This tends to increase the general level of selling prices, or *vice versa* to decrease the general level of profit, to the disadvantage of the remaining customers or the stock-holders as the case may be.

Because the foregoing economic considerations are usually not clearly understood by sales personnel, there is a widespread and natural tendency for sales personnel continually to advocate the making, stocking and selling of items not previously sold, under the mistaken impression that each additional item available for sale will simplify the attainment of sales income objectives.

### 2. Competitive

Unless top management is aware of the economic fallacy of this sales argument, they may well accede to the wishes of the sales personnel to the economic detriment of the organisation as a whole, the stock-holders, and the majority of customers. In fact, top management frequently adopts these sales arguments on the basis that: "If we do not supply to this customer the marginal item he needs, our competitors will. We will consequently lose our customer's good-will and he will also tend to buy the more popular items from our competitors in the future." *This argument fails to recognise the fact that the diplomatic refusal to satisfy marginal customers' demands tends to generate a competitive advantage by reducing selling and stock costs, thereby enabling selling prices to be reduced.*

Since such managerial justification for satisfying the needs of marginal customers is prompted by competitive considerations, it is customary to find the same argument being advanced by competing concerns within the same industry, to the detriment of all, including the non-marginal customers. Where this is a widespread phenomenon, as it is in most European countries, it cumulatively exerts an adverse influence on the national economy by reducing productivity and lowering the standard of living.

### 3. Collective Action

The solution to such a condition at the national (or international) level lies in the promotion of intelligent collective action at the same level. This was recognised in the United States over 30 years ago by the creation of a Simplified Practice Division within the (Federal) Department of Commerce. The function of this Division (now known as the Commodity Standards Division) is to provide an independent, neutral product variety reduction service which competing manufacturers, distributors or their customers can avail themselves of in the interest of collective simplification of selling practices.

### 4. Variety Reduction and Standardisation

The procedure used by the United States Commodity Standards Division to a certain extent parallels that used by many national standardisation institutes, including the American Standards Association, during the formal process of developing a standardised range of products. There is, however, an essential difference in emphasis between the two activities. The variety reduction functions of the CSD are concerned solely with products that are already made and sold and with applying a sieving-out process to eliminate the marginal, unpopular and uneconomic products in the interest of increased productivity and lower costs through simplification.

The objective of the standardisation process, as generally conceived, is to establish desirable product criteria with respect to operating characteristics, size, shape, quality and the like. In the process of doing this, the standardised products may prove to have a lower range of sizes than prior to standardisation which, from a productivity point of view, is commendable. However, since desirable criteria is the main objective, the standardised products may be completely new or, at least, modifications of products previously made.

The establishment of valid product criteria also entails time-consuming research, and much-needed reduction in the variety of products offered for sale may be delayed because of the emphasis on standardisation rather than simplification. In many cases, in fact, standardisation by the American Standards Association has been simplified and facilitated by prior variety reduction through the services of the C.S.D.

There is a growing recognition in Europe of the relationship between simplification and standardisation, and some national and international bodies similar in function to the C.S.D. and not necessarily tied to the standards institutions, are functioning or are being contemplated; particularly in Germany, the Netherlands, Norway, Belgium and the Nordic countries.

The Commodity Standards Division has a long record of over 500 successful projects in reducing product variety. The degree of reduction achieved in particular cases ranges from 27% to as high as 98%. The logical outcome of this type of activity is the promotion of a managerial concept of product variety restriction and control. The head of one very successful equipment company expresses it in these terms:—"The salesman always wants to sell products you haven't got, and if you let him influence you, you will be continually developing new products and so reducing the sales emphasis on the existing products." This is not to say that product development and its related research should be discouraged, but rather that it should be guided towards the development of products which show distinct promise of the wide customer acceptance which is characteristic of popular products. It is this type of progressive managerial thinking which, in large part, accounts for the higher productivity achieved by U.S. industry. To achieve the ultimate productivity benefits from such reduction, restriction and control of end-product variety, however, a similar type of simplification has to be applied during the product development and design process, and during manufacture.

## III.—SIMPLIFICATION IN DESIGNING.

The process of product design and its related preparation of manufacturing specifications provides the greatest potential for increasing productivity through simplification and standardisation. Simplification has two aspects: one represents a challenge to the designer, the other a challenge to design management.

### 1. Productivity and Design

It is perhaps not as fully realised as is desirable that *the design department of a manufacturing and selling organisation exerts a controlling influence on the potential productivity of the manufacturing and selling activities of the organisation.* It is during the design process that the degree of simplicity or complexity of a product is determined.

If the designer creates a product design of higher complexity than is necessary for satisfactory performance, he lowers the productivity potential in its manufacture and thereby increases its manufacturing cost, which tends to increase the selling price and reduce the customer's willingness to buy. When a designer creates a product that is deficient in appearance or style as compared with its competing products, even though it may be competitive or superior in all other respects, he also reduces the customer's willingness to buy. Evidently, then, on the score of both simplicity of design and attractiveness of appearance, the designer exerts a potent influence on both sales and manufacturing productivity. These are the aspects of simplification in design which represent a challenge to the designer.

In consumer product design, where styling aspects are most important, a further challenge to the designer lies in achieving the variations in style needed to stimulate customer willingness to buy through variations in the more superficial aspects of design, such as colour and accessory trimmings which cause only minor variations in manufacturing cost because they do not adversely affect the manufacturing process. This aspect is dealt with later under "Problems of Simplification in Manufacturing."

### 2. Productivity and Design Management

The challenge to design management is to achieve the design of the optimum variety of end products, as dictated by the demands of optimum sales productivity, using a minimum variety of interchangeable components, basic materials and tools. When it is considered that most end products are compositions or assemblies of tens or hundreds, sometimes even thousands, of components, the full import of this challenge becomes apparent. This is particularly so in the case of general engineering factories supplying capital goods.

Usually industrial organisations confine themselves, either divisionally or totally, to making and selling a line or range of sizes of related and functionally similar products. In such cases the manufacture of the components for all the end products can be largely based on the same range of basic materials as for any single product. This means that there is frequently a natural degree of potential interchangeability of basic materials as between the components of the various end products.

This natural interchangeability has to be fostered by the designers of the various products, however, if its full potential is to be achieved. The advantage of such achievement lies in the generation of maximum practical ordering quantities for each material, which permits economical purchasing and simplifies the stock control and purchasing functions by reducing the quantity of different orders processed.

### 3. Interchangeability and Modular Aspects

There is usually also a natural degree of potential interchangeability between varying sizes of functionally similar products at the component part and subassembly levels of design. Such potential interchangeability frequently has modular aspects arising from the common functional background of the products. For instance, the need for all sizes of prefabricated refrigerators—whatever their cubic capacity—to be able to pass through the normal doorway, is a simple illustration of these modular aspects. It naturally induces a design tendency for close similarity of height and depth as between all such refrigerators even when they are independently designed.

To achieve actual interchangeability of the side panels for a given manufacturer's range of refrigerators, however, this modular aspect of the design has to be recognised by design management and the designers of the various sizes have to be induced to adopt collectively a standard side panel design of common shape, construction and size. Fig. 7 shows

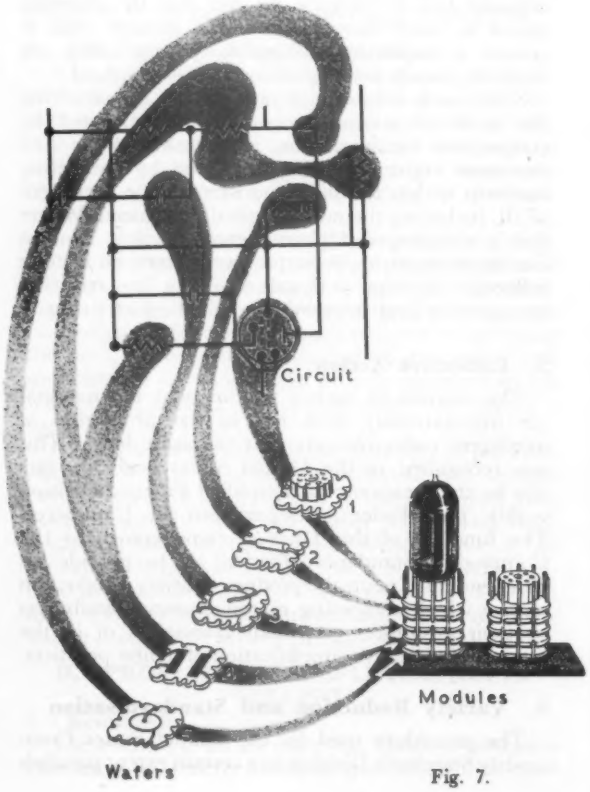



Fig. 7.

an application of the modular principle in the design of electronic apparatus which facilitated the accomplishment of automated manufacture. The modular concept is based on the feasibility of developing a series of standard interchangeable circuit patterns which can each be accommodated within a standard module.

The module is a stack of five to eight standard square ceramic wafers, spaced and held apart by three tinned copper riser wires soldered in position in grooves in each of the four sides to form a rigid $\frac{3}{4}''$ square column approximately $1\frac{1}{4}''$ high.

A wide variety of circuit patterns incorporating valves, resistors, capacitors, potentiometers and other components can be accommodated in a standard module. This is achieved through the medium of printed circuitry and attached components on the lower and upper surfaces of each standard wafer appropriately inter-connected between wafers by one or more of the riser wires.

The modules are assembled into electronic devices by inserting and soldering the lower ends of their riser wires into appropriate circuits etched onto the under surface of insulation base plates as is indicated in Fig. 7.

### 4. Interchangeability, Standardisation and Productivity

*Interchangeability of standard parts and sub-assemblies increases the productivity of both the design and manufacturing departments.* Generation of standard part and sub-assembly interchangeability during the design process prevents needless duplication in preparing designs, drawings and other manufacturing specifications for closely similar or identical components. Properly organised, this standardisation simplifies the product design and the tool design and manufacturing functions; enables the product and tool design staffs to increase their productivity by producing designs, drawings and manufacturing specifications for more products, and consequently reduces the design and tooling costs per product.

Such interchangeability also generates larger manufacturing and purchasing quantities because the demand for each interchangeable standard component is the sum of the demands for each of the end products into which it may be incorporated. This enables the fixed costs pertaining to each such standard component for product design, tool design and manufacture, manufacturing or purchase order preparation and control, and tool set-up for each manufacturing order, to be apportioned over a greater quantity than would otherwise be possible. This reduces the fixed costs per unit component due to the increased design and manufacturing productivity generated by interchangeability and standardisation.

### 5. Simplification, Standardisation and Specialisation

Another salient advantage arising from the larger production quantities generated by simplification through interchangeability of standard materials, parts and sub-assemblies, lies in the economic justification such quantities provide for the utilisation during manufacture of specialised personnel and/or equipment. Such specialisation pays big dividends in terms of increased productivity and decreased costs, but is only possible when reasonably large quantities are to be manufactured. It reaches its zenith under mass production conditions. This aspect is dealt with later under "Simplification in Manufacturing."

## IV.—PROBLEMS OF SIMPLIFICATION IN DESIGNING

### 1. Schizophrenic Aspects

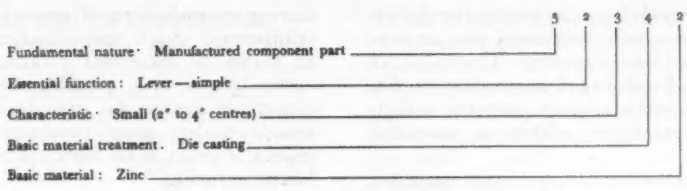
Fundamentally the designer's ultimate objective is to create an end product whose design is sufficiently unique in most, if not all, of its aspects to induce more customers to buy his design than its competitive counterparts. The need for the designer simultaneously to promote increased design and manufacturing productivity by creating or adapting non-unique standard components which are interchangeable between his unique end product and the equally unique end products of his colleagues, tends to create a schizophrenic condition which design personnel instinctively tend to avoid. Consequently, unless it is made very easy for a designer to find out what standard component designs or stocks of basic materials already exist, which fit or can be adapted to his needs with regard to a particular component, he will argue that it is easier, and therefore more economic, for him to design a new component using whatever materials he considers proper.

To combat this very natural tendency of designers to design components independently, it is necessary, in the interest of design, manufacturing and sales productivity and economy, for design management to promote the development and maintenance of quickly found and easily assimilable standard data with regard to all interchangeable sub-assemblies, parts and materials. Perhaps the most effective means by which this can be achieved is through the systematic identification of each such item, whether a material, a part, a sub-assembly or an end product according to its fundamental nature and its essential function.

### 2. Identification and Classification

Such identification systems provide a method of systematically classifying potentially interchangeable items in such a manner as to enable a designer to build up readily from a code book, the classification number for a type of material, part or sub-assembly he needs for incorporation into his end product design. The manner in which the designer may develop such a component classification number is shown in Fig. 8. He can then refer to the standards files and obtain complete information regarding each of the range of standard items available within the class in which he is interested.

In the case of materials, the designer would, for instance, obtain from the files data as to preferred sizes or compositions and whether each size is in stock. In the case of parts or sub-assemblies, he would obtain design data such as dimensions, basic materials and methods of fabrication for each previously designed component within the class. Thus the


3 2 3 4 2
Fundamental nature · Manufactured component part
Essential function : Lever — simple
Characteristic · Small (2" to 4" centres)
Basic material treatment . Die casting
Basic material : Zinc

Development of Typical Component Classification No.

FIGURE 8

selection by a designer of a preferred or stocked material or a component suitable for use, with or without adaption, in the end product he is designing, is simplified and the designer's productivity enhanced.

### 3. Introducing Classification

The introduction of such a classification system into an organisation in which interchangeability of standard materials and components has not previously been a design management policy, can produce considerable financial savings. In such cases, due to modular aspects, similarity of end product functions, and chance causes, a considerable degree of inadvertent, unplanned interchangeability of components and materials usually exists. The systematic classification process inevitably reveals items whose identity or similarity has previously been obscured by haphazard or inaccurate nomenclature.

It is not unknown in such cases to find upwards of 10 or even 20 differently numbered independently prepared drawings or specifications identified under the same classification code number; indicating that they are all functionally and materially identical or closely similar, and that almost all of them were needlessly prepared.

The eradication of such conditions, while eminently desirable, is not easy to achieve and must be carefully planned. It raises such questions, for instance, as whether the classification coding system is to replace or supplement the existing system of nomenclature. The existing system may involve many thousands of items and the cost of complete change-over to the classification code system may appear prohibitive. The items in current production may, however, represent a minority of the items covered by the existing system. A compromise solution may, therefore, be practical on the basis of replacing the existing system by the classification system in the case of current items only.

If, in the initial stages, the application of the classification system is done strictly on a random sampling basis, the average percentage of total available design, drafting and tooling time unnecessarily spent on duplicated items in the past may be estimated with reasonable accuracy. This data, projected into the future to show probable savings, and compared with the estimated cost of changeover to the classification system to determine the period required for savings to amortise cost, can provide a valid basis for a sound decision by design management.

In any case, the decision should not be made solely on the basis of anticipated savings in design, drafting and tooling costs. The adoption by the design department of a systematic method of classifying materials, components and end products will also produce savings in the manufacturing department, particularly with respect to stock-keeping, production scheduling, materials and component control and manufacturing set-up costs. This will be dealt with later in detail under " Problems of Simplification in Manufacturing."

### 4. Simplification, Standardisation and Specification

Once all functionally identical or similar components have been revealed and their similarities resolved by unification and consolidation under their generic classification code numbers, the classification system will clearly show that each remaining component is a distinct product with its own unique functional and material characteristics. It has to be recognised that each such component is potentially, if not actually, interchangeable between various end products or their sub-assemblies and cannot therefore validly be identified with one particular end product or sub-assembly. It is essential, therefore, that the unique character of each component part and assembly be crystallised by depicting or stating its manufacturing data on a separate drawing or other manufacturing specification.

If this requirement is not established and enforced as a design management policy, the designer's natural preoccupation with the end product may lead him to bury any new component specifications within the specifications for the end product into which the component is primarily to be incorporated. Such practices inhibit simplification and standardisation and prevent the interchangeable use of components in other end products which may be designed later.

## V.—SIMPLIFICATION IN MANUFACTURING

*It is during manufacture that the productivity potential produced by simplification of the selling and design processes must be realised.* The quantity of each end product to be manufactured is increased to the extent that hard-to-sell marginal items are eliminated, and total end product demand is concentrated on fewer, easier to sell products. The quantity of each component to be manufactured or purchased is further increased to the extent that the restricted range of end products is designed to be made from a minimum variety of interchangeable components. Then the demand for each component is determined by the total demand for all the end products to which

it is interchangeably applied, and the quantity of the component required in each end product. Thus simplification of selling and design cumulatively act to increase production quantities and lead the way to increased productivity and reduced costs during manufacture.

### 1. Productivity and Power

Fundamentally, the greater the amount of useful power applied during a manufacturing process, the higher the productivity. This is true, because the productive work required to convert primary materials into a product as designed is relatively constant. Consequently, the greater the power applied in performing this quota of work, the more quickly the work will be accomplished.

The fundamental problem in manufacturing, then, is how to bring the maximum practicable amount of power to bear on accomplishing the work which must be done at each stage in the manufacturing process. It is characteristic of manufacturing operations that sizable amounts of power are frequently required in accomplishing the necessary productive work. The maximum practical amount of power which can be applied in a given case is, first of all, determined by the ability of the product in process to withstand the application of necessary force without undue distortion. Obviously, a robust product can withstand much higher productive forces than a fragile product. Consequently a robust product has a much higher productivity potential than a fragile one.

The ability of human beings to apply power during a production process is strictly limited and, therefore, to achieve the highest possible productivity, the utilisation of manpower in manufacturing should be confined to those tasks in which the maximum applicable amount of power is well within the human power range. This necessarily excludes the utilisation of manpower for productive work, except on the most fragile products and the most delicate productive tasks.

There are four classes of work within a manufacturing process to which power may be applied to increase productivity. They are:—

1. Productive work tasks during which the primary materials are changed in shape, appearance, chemical composition or physical characteristics, or are joined together to form the product as designed.
2. Work involving routine movement of processing equipment or functioning parts thereof.
3. Materials movement work within and between manufacturing process steps.
4. Control work involving initiation and appraisal of work task performance, comparison thereof with the criterion of performance, and adjustment of processing equipment when necessary to ensure the achievement of the criterion.

Of these, the productive work tasks require the greatest expenditure of power. They, therefore, have the greatest potential for productivity increase. Consequently, in industry, power is most frequently applied to the accomplishment of such productive work through the medium of general purpose, power-driven equipment which can be adapted to perform particular work tasks by the temporary application of such accessories as materials holding attachments and cutting or forming tools.

*The economic justification for the procurement, installation, maintenance and use of such general purpose equipment is that the apportioned cost for its use per unit produced, based on its useful life, must be more than offset by the reduction in cost per piece resulting from the increased rate of production it achieves as compared with the alternative manual performance of the work task.* The man-to-machine power ratio, particularly in the case of robust products, is usually large enough to generate substantial reductions in processing costs per piece, provided the equipment is utilised for productive work for a major portion of its potential working life.

### 2. Temporary Specialisation in Intermittent Manufacture

The adaptation of general purpose equipment to the performance of a particular productive work task by the application of accessory attachments temporarily converts it into a specialised device. It remains so for the duration of the productive work task for which it was so adapted or set up, and then the accessory attachments are dismantled. During the application and dismantling of the accessories it is impossible to utilise the equipment for productive work. On the average, the greater the proportion of the machine's potential working time used during the application and dismantling (set-up and tear down) of accessory attachments, as compared to its utilisation for productive work, the lower the productivity and the higher the manufacturing costs.

It is necessary, in the average industrial case, to use general purpose equipment, because the quantity of each product (part or assembly) to be processed is not great enough to absorb the full working capacity of one piece of equipment on each of its process steps. This condition is typical of jobbing work or non-mass produced, intermittently-made products. It is a condition which is aggravated to the extent that the application of power to productive work, and the sub-division of the manufacturing process into productive segments, collectively reduce the processing time per piece at each process step; because the shorter the time per piece, the greater the quantity of pieces needed to absorb the whole working capacity of the machine.

### 3. Batch Production Conditions

Such intermittently-produced products must necessarily be fabricated in batches at each manufacturing process step, and before manufacture of each batch can commence, much preparatory work must be done. The requirements for the product in the immediate future must be appraised and a decision made as to the batch quantity to be produced. Manufacturing order paper work, primary material stores requisitions, work tickets and tool requisitions for each step in the manufacturing process must be prepared and despatched to the personnel controlling the various and sometimes widely separated working areas in which the items of equipment to be used during the manufacturing process are located.

Before each process step can start, work tickets have to be issued and the particular item of general purpose equipment to be used must be set up, i.e., temporarily converted into a suitably specialised device; involving withdrawal of the necessary processing attachments from store-rooms, their attachment and adjustment, a process which is frequently time-taking and expensive.

In like manner, after the completion of each step in the manufacturing process, the processed parts have to be inspected for quality, the set-up accessories have to be dismantled and returned to the store rooms, data regarding the work task, such as quantity processed, elapsed time, spoilage, etc., must be recorded on work tickets and appropriately despatched, and pertinent accounting and stock records must be posted.

*The cost of all this make-ready and put-away work represents a considerable fixed expense chargeable to each batch of parts processed, no matter how small the batch may be. Obviously, the smaller the batch quantity, the larger the make-ready and put-away charges per unit produced.* The exponential influence of these fixed expenses on unit production cost is shown in Fig. 9.

Since the sequence of process steps is different for each product manufactured, it is impossible to locate the various items of general purpose equipment used for the range of products manufactured in any logical sequence relative to the process sequence for a particular product. Such equipment is, therefore, usually installed in functionally similar groupings, either sectionally or departmentally, such as forge shop, machine shop, foundry, tank shop, etc.

The route each batch of products follows from one piece of general purpose equipment to another in accomplishing the sequence of production operations which constitute the manufacturing process for the product, is largely determined by random chance. This usually entails at least as many transportations and storages between process steps as there are steps in the manufacturing process.

The random distances transported are frequently considerable and the length of each storage tends to be determined by the product's success or otherwise in competing with other products for the use of a particular machine's capacity. This competition is keenest and the delays in storage the longest when the demand for machine capacity is highest. *Such conditions generate large stocks of partially processed products between process steps.*

In-process stocks occupy much valuable and potentially productive floor space and materials handling personnel. Such stocks also absorb large amounts of working capital and prolong the production process, thereby reducing the rate of turnover of the working capital. Batch type production of intermittently manufactured products is, therefore, characteristically high in cost and low in productivity.

### 4. Quantity, Power and Productivity

In processing small batches, it is economic to accomplish only the productive work by the application of machine-applied power, and for the remaining three types of work to be performed manually by the operator of the equipment. As the size of the batch increases, this manual work becomes increasingly repetitive and the operator begins to achieve a certain degree of habitually rhythmic performance of the work task motion pattern. This generates an appreciable decrease in the time required to perform the non-productive work, and consequently increases the productivity and reduces the cost per unit produced.

As the batches become larger, it becomes more economical to perform the non-productive work within process steps by means of power applied through more specialised machines. This particularly applies to the routine movement of functioning parts of the processing equipment such as cutting tools, and to the placement and securing of materials in position for processing as, for instance, in automatic screw lathes.

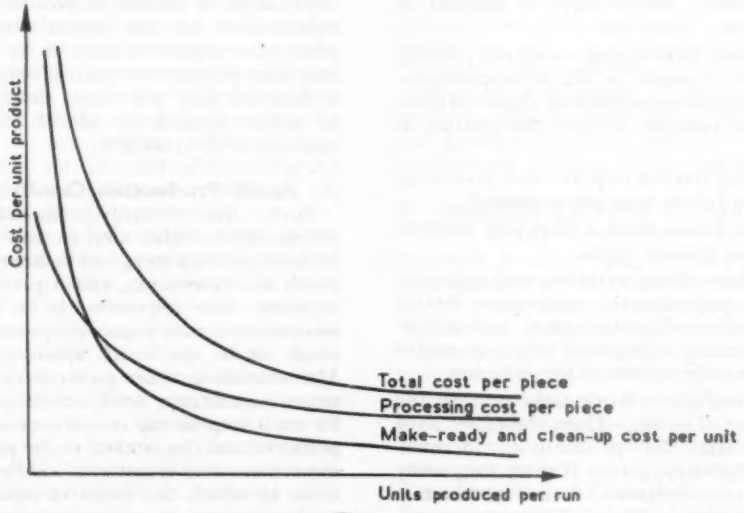

Cost per unit product
Total cost per piece
Processing cost per piece
Make-ready and clean-up cost per unit
Units produced per run

Figure 9

The setting up and dismantling of more narrowly specialised equipment is much more complicated and costly and can, therefore, only be economically justified for the processing of very large batches. In such cases, the machine operator's duties are mainly confined to intermittent performance of the control class of work, so far as any one item of equipment is concerned. Consequently, it is then practical for one operator to control the performance of a number of such machines, thereby further increasing productivity and reducing costs per part processed.

The attachment of parts together to form assembled products usually involves much more expenditure of human power than does the machine forming and shaping of primary materials during the making of the parts, though frequently the manpower is supplemented by the use of portable power tools. Here, also, a progressive trend towards larger batches provides greater economic justification for the application of work simplification methods through which wasteful human motions may be eliminated, productivity increased and assembly costs reduced.

## 5. Mass Production Conditions

As batches become progressively larger, they ultimately qualify for the application of mass production techniques during manufacture. *This point is reached with respect to a particular product when the quantity to be produced, in terms of a given sequence of manufacturing process steps, is sufficient to absorb the major part, if not all, of the production capacity of at least one productive unit at each process step.*

Since the processing time per piece at any process step tends to be inversely proportional to the amount of power which can be applied to the productive work involved, fragile products tend to qualify for mass production techniques at lower quantities than do robust products.

The processing time per piece at each process step is also inversely proportional to the number of process steps into which the whole manufacturing process for a component is divided. Consequently, when a manufacturing process is divided into too many process steps, its mass production quota is higher and the application of mass production methods is delayed, if not prevented. In addition, a too-fine division of labour frequently implies too many—and therefore unnecessary—handlings of the product by working personnel and, in the case of batch production, too many opportunities for storages and delays of the product between process steps.

As soon as a standard component part or assembly is required in mass production quantities, it becomes possible to simplify its production process and its attendant preparation and clean-up work by setting up a specially designed, closely co-ordinated flow-type manufacturing process for the product.

## 6. Mass Production Methods

The essence of the flow type mass production line method of manufacture is that, because the mass production conditions justify specialisation of the processing equipment and attendant personnel for the production life of the product, it becomes practicable to instal the various items of processing equipment according to the sequence of steps which comprise the manufacturing process. This facilitates a product flow condition wherein, as soon as any given process step has been completed, each product moves singly and directly to the next process step.

*The fundamental requirement for actually achieving the desired flow condition between process steps is that the initiation and termination of all sequential steps within a process be substantially coincidental, thereby enforcing simultaneous transfer of single products between sequential process steps. This implies that all the process steps shall be of equal time duration.*

In any given manufacturing process, there is always one bottle-neck operation which inherently has a longer processing time than any other step in the process. The inherent production rate at this bottle neck operation tends to determine the production rate for any mass production line sequence of process steps of which it forms a part. Consequently, recognition of this natural bottle-neck operation and its inherent characteristics is a fundamental prerequisite to the design of a mass production line manufacturing process.

Having identified the natural bottle-neck operation, it then becomes necessary to use its inherent process time and production rate as the criteria for the remaining process steps which are to comprise the mass production line process. Assuming the starting point to be an existing batch production process, wide variations may exist between the inherent production rate of the bottle-neck operation and those of the remaining operations in the existing manufacturing process. These variations have to be reconciled or balanced out if the desired flow condition of the product within the production line is to be achieved. This is the major challenge to the process engineer in developing his process design.

Balance between the various steps in a mass production line process is achieved to the extent that through a logical combination of existing process steps or portions thereof, and their modification and location so as to achieve motion economy by operating personnel, the processing time at each step matches that of the bottle-neck operation. Exact balance is practically impossible to achieve, and probably the most that can be reasonably expected is that the percentage variation from the bottle-neck operation time be within the inherent error for the method of work measurement used in determining the times for each of the process steps.

Realising the practical impossibility of exact balance, it has to be recognised that the rate of output from the production line will inevitably be governed by the process step which has the highest inherent processing time.

In order to ensure realisation of the desired product flow condition, each sequential step in the process must be able to accept each product as soon as it has completed its immediately preceding process step. This can only be achieved when the first step in the process has an inherent processing time which matches identically or slightly exceeds that of the natural bottle-neck operation. Otherwise, the rate of production prior to the bottle-neck operation

would be higher than that of the bottle-neck operation, and products would tend to accumulate ahead of it.

If the natural bottle-neck operation occurs anywhere in the process other than at the beginning, therefore, an initial process step must be synthesised which definitely matches the natural bottle-neck.

Under such conditions of balance between process steps, it becomes practicable to instal the various items of processing equipment as close to each other as working conditions for operating personnel permit and to position the equipment, not in a line, but at whatever angle is necessary to achieve the most direct transportation of the product from one process step to the next, depending upon the relative point of egression and entrance of the product out of or into the equipment.

Such equipment installation facilitates the use of the simplest, most direct and, therefore, most economic automatic materials transfer between process steps. In the case of a process in which there is a worker servicing and controlling each process step, it is usually most economical for each worker to pick up and lay down the product on either side of his process step at the point where the preceding and succeeding workers laid down and will pick up the product respectively. When the product is automatically ejected from a process step upon completion, a simple chute most economically fulfils the need for automatic transportation to the next process step.

### 6. Automatic Conditions

Such co-ordinated groupings of product processing equipment can be developed for the mass production of machined or formed parts, or for progressively attaching parts together to form assembled products. When this method of production is developed to the point where not only productive work but also the positioning of materials and tools for processing, the transfer of materials from one process step to the next, and at least the routine aspects of process control, are achieved by an integrated assembly of power driven equipment without direct human aid, automation in manufacture is realised.

### 7. Mass Production Line and Automation Benefits

The outstanding advantage of such mass production line or automated manufacturing processes is that the processing time for the product tends to approximate the bottle-neck operation time multiplied by the number of process steps. This relatively short production period facilitates quality control. In addition, the group of integrated items of equipment comprising the production line can be treated as one machine for purposes of production scheduling and production control, because whatever products enter the process at a given rate, tend to leave it at the same rate.

*The substantial elimination of storages and delays of the product between process steps drastically reduces the in-process stocks and the costs thereof, eliminates multiple handlings of batches of materials between steps, drastically reduces working capital needs and tends to accelerate its rate of turnover.* Consequently the overall process of manufacture, its scheduling and its control, is greatly simplified and, because of the much lower working capital needs, it is usually more than self-financing.

In one case, where an 11-step batch process was replaced by a 7-step mass production line, annual labour savings were $2,400 and the reduction in carrying charges on in-process stocks was $127,600 for a total saving of $130,000 per year. In addition, the drastic reduction in in-process stocks released working capital funds in excess of $630,000. The cost of redesigning the process and relocating the processing equipment was approximately $10,000.

It is obvious, then, that simplification in selling and in designing can provide increasing opportunities for simplification in manufacturing by collectively generating the production of progressively larger quantities of end products, sub-assemblies and parts, until ultimately maximum productivity and minimum costs are achieved through manufacture and sale in mass production quantities.

## VI.—PROBLEMS OF SIMPLIFICATION IN MANUFACTURING

### 1. Generation of Maximum Practical Order Quantities

It is apparent that the basic problem of simplification in manufacturing is to provide the maximum opportunity for the application of manufacturing simplification techniques with respect to each part, sub-assembly, and end product manufactured by promoting the largest practicable production quantity in each and every case.

In the final analysis, the quantities to be produced are determined by the customers' demands for the various end products. This sales demand may fluctuate widely, for seasonal and other reasons, with respect to particular products or groups of functionally similar products. Top management has, therefore, to decide whether to allow manufacturing quantities to reflect the perhaps wide variations in sales demand, or whether to manufacture or purchase parts, sub-assemblies or end products to some extent for stock during periods of low sales demand, with the intent of allowing such stocks to be depleted during periods of high sales demand, so as to achieve as constant a level of manufacture of each product as is economically practical.

*In arriving at such decisions, there is no substitute for accurate sales statistics, as previously discussed under "Simplification in Selling."*

It has to be borne in mind also that total manufacturing capacity tends to be determined by the long-term average sales demand for all products purchased. Consequently, the minimum and maximum sales demands may represent drastic under-consumption of manufacturing capacity on the one hand, and a heavy overload on the other.

In the first case, the necessity of manufacturing in small batches and of spreading fixed overhead charges over a reduced production base would greatly increase the manufacturing cost per piece. In the second case, the overtime work necessary to meet the overload would also cause increases in manufacturing costs per piece. It is frequently

advisable, therefore, to devise a production scheduling procedure which will lead to appraisal of the known and anticipated demand for each primary material, part or assembly during the process of determining the most economical quantity to purchase or manufacture.

It is the normal function of production scheduling to convert actual and anticipated end product demand into purchase order requisitions for primary materials and purchased components and into manufacturing orders for parts, sub-assemblies and end products. This entails determining the total demand for each such item in terms of the total demand for the end products to which it may be interchangeably or singly applied. This can be most conveniently achieved through the integration into the scheduling process of a materials and components control procedure.

The vehicle for materials and component control in any given case is a control record designed for the convenient entry thereon of all pertinent data regarding the item to be controlled, such as is illustrated in Fig. 10. The maintenance of such control records provides a convenient source of reference from which to determine the quantity of any material, part of assembly available or on order, the size and date of previous orders, the components and end products to which it may be interchangeably applied, the rate of usage, and the range of variation therein.

As end product demand is translated, during the scheduling process, into its equivalent demand in terms, successively, of sub-assemblies, parts and materials, the demand for each such item is entered on the control record and deducted from the balance available for allocation. If, in terms of the normal rate of usage of the item, the remaining balance is judged to be in need of replenishment, a replacement order has to be issued.

If the recorded use of the item is intermittent and shows a wide variation, the probable demand for the item in the immediate future in terms of the end products and components to which it is applicable is appraised in the process of deciding the order quantity, which is judged to be the most economical in the circumstances.

## 2. Economic Order Quantity Calculation

If the yearly average recorded use of the item proves to be relatively constant, it then becomes possible to determine the most economical purchase or manufacturing order quantity with reasonable accuracy through the use of the generic formula for such calculations:—

$$Q = \sqrt{\frac{2PN}{VT}}, \text{ where}$$

Q = Economic number of pieces to order.
P = Preparation (and receiving) charges per order.
N = Estimated number of pieces required per year.
V = Value per piece placed in stock.
T = Total storage, interest and carrying charges per year in per cent. of the average value of the stored products (expressed as a decimal, i.e. 24%—0.24).

It should be recognised that when the above formula becomes applicable in the case of manufactured items, mass production quantities may have been achieved, particularly in the case of assemblies or fragile products for which the mass production quota may be relatively low by virtue of their low productive power requirements.

In essence, with such materials and components control, each item is purchased or manufactured, at least nominally, for stock. In the case of items having widely variable usage, however, their actual application to their parent products may be so close to their procurement as virtually to prevent the accumulation of stock.

## 3. Stock Control Limits

When the economic ordering quantity formula becomes applicable, there is every likelihood that some stock of the item will accumulate and, in fact, the formula takes this probability into account. It then becomes feasible also to state standard stock

STOCK CONTROL RECORD

| Classification No. 52342-174 | | | Description LEVER | | | | BIN No. 1-64 | | |
|---|---|---|---|---|---|---|---|---|---|
| Ordering Level 600 | | | Ordering Quant. 1000 | | Expediting Point 300 | | Max. Quant. 1400 | | |
| ORDERED | | | RECEIVED | | | Balance Available for Allocation | ALLOCATED | | |
| Date | Order No. | Quant. | Date | Order No. | Quant. | | Date | Order No. | Quant. |
| | | | | | | 0 | | | |
| 1-27 | P 5721 | 1000 | | | | — 400 | 1-27 | M 111 | 400 |
| | | | 2-3 | P 5610 | 500 | 100 | | | |
| | | | | | | — 600 | 2-5 | M 129 | 700 |
| | | | 2-10 | P 5610 | 500 | — 100 | | | |
| | | | 2-21 | P 5721 | 1000 | 900 | | | |
| | | | | | | 700 | 2-28 | M 143 | 200 |
| | | | | | | | | | |
| | | | | | | | | | |
| | | | | | | | | | |

FIGURE 10

control limits on the control record. Such limits are normally determined as follows:—

(*a*) *Ordering Level*: either the maximum usage during the expected procurement period, or the maximum usage during the average period between issuance of replacement orders, whichever is the smaller.

(*b*) *Expediting Point:* the maximum usage during the maximum expediting period (the maximum expected period between initiation of expediting action and receipt of sufficient of the stock on order to sustain operations until normal deliveries are made.)

(*c*) *Maximum Quantity*: the ordering level minus either the minimum usage during the procurement period, or the minimum usage during the average period between issuance of replacement orders, whichever is the smaller—plus the economic ordering quantity.

### 4. Advantages of Classification in Scheduling and Stocking

The classification of materials, parts and assemblies is of particular value in simplifying scheduling and stocking problems. Because it eliminates duplication of specification and nomenclature for identical and similar items, it guards against duplication of control records and work thereon and ensures that the largest practicable order quantity will be generated in each case, in the interest of purchasing or manufacturing economy.

Classification also guards against duplication of stocks, and tends to reduce the capital expenditures for financing the items stocked, their handling and protection and the provision of necessary storage space and facilities. In addition, classification consolidates and increases the demand for each item stocked and tends to increase the rate of stock turnover.

Cumulatively the classifying of materials, parts and assemblies tends to increase earnings with a lower capital base. In fact, the introduction of such a classification system into an organisation in which interchangeability of materials and components has not previously been a matter of management policy, has been known to reduce stocks by as much as 25% or 30%, thereby generating commensurate reductions in annual stock costs and capital demands.

Since the classification system facilitates recognition of similar items, it also simplifies the sequential scheduling of manufacturing operations on parts requiring the attachment of identical or partially identical accessories to general purpose machinery during set-up, thereby enabling reduction in set-up and tear-down costs for the items scheduled and improving productivity.

### 5. Advantages of Classification in Process Design

Frequently, the outward difference of appearance within a group of functionally similar products may be achieved by variations in such aspects as colour and accessory fittings, which may not cause sufficient variations in their several manufacturing processes to justify regarding them as different products for purposes of manufacture. The classification of each part and assembly according to its fundamental nature and its essential functions, facilitates recognition of such groups of similar products by classes. This is a considerable advantage in process design because *it makes it easier for the designer to recognise the groups of outwardly different products whose manufacturing processes are sufficiently similar to be grouped together for purposes of manufacture.*

In such cases, mass production quantities can be more quickly achieved in terms of the total demand for the group than would be possible for any of its several products. Consequently the high productivity, low manufacturing cost and low capital demand generated by adoption of mass production line methods can be achieved earlier than would otherwise be possible. In one case, it was possible to accommodate 56 outwardly different highly styled end products (eight styles each in seven colours) within a single mass production line process, thereby generating the savings in in-process stock costs and working capital previously referred to under "Simplification in Manufacturing."

## VII.—CONCLUSION

It is evident that simplification and standardisation in selling, design, or manufacture can each make a contribution to increased productivity, lower costs and reduced selling prices. Their combined effect makes possible significant increases in earnings for workers, executives, owners or stock holders alike while, at the same time, radically reducing capital needs and enabling products to be offered to consumers at lower prices. In terms of the national economy, this promises a progressively higher standard of living to all levels of society. The fulfilment of that promise is a challenge to top management.

*The ultimate rewards from simplification and standardisation cannot be achieved by a complacent management. They demand a management with the vision, the social responsibility and the courage to recognise that these rewards have to be earned, to be planned for and organised on a permanent and continuing basis. Because their full achievement demands co-ordinated action by all divisions of industry, the ultimate responsibility for their attainment must necessarily be accepted by top management.*

Management needs to recognise, however, that the working responsibility for achieving simplification must be delegated to subordinates who, by virtue of specialised training and experience, are able to induce the acceptance of simplification measures by the organisation on management's behalf. Such specialists, guided, supported and sustained by intelligent and progressive management, can ensure the economic health of the organisation to which they belong. Indeed, collectively, and aided by appropriate national simplification and standardisation bodies, they can ensure a progressively healthier national economy.

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**SESSION XII**

# INVESTING IN WORK STUDY


by A. J. SPEAKMAN,

Head of the Work Study Unit, British Productivity Council

**Mr. Speakman**

*Mr. Speakman, first Technical Officer of the British Productivity Council, was appointed Head of the Work Study Unit twelve months ago. Originally he was trained as a mechanical engineer. He has spent the last fifteen years in the field of production engineering with particular reference to the application of Work Study. He is the author of "Work Study and Incentives — An Introduction" and various articles for the technical press. During the War he was Regional Production Engineer, Ministry of Supply, and at one time Divisional Work Study Officer, Imperial Chemical Industries Ltd. He has recently returned from a visit to Holland as a member of the British Productivity Council's Team and also visited Germany for the purpose of observing industrial efficiency in the engineering industry.*

### The Economics of Productivity — The Reason Why

The inescapable fact about the present industrial situation is that our standard of living, let alone a better one, can only be maintained if all those engaged in industry concentrate their efforts on reducing the costs of manufacture, distribution, and administration. A higher standard of living, whether by higher wages or reduced prices, better social services or reduced taxation, can only be achieved by higher productivity. Work — effective work — must increase to a point where it is commensurate with the high wages being paid in the majority of industries.

The approach to the problem, however, is often clouded by emotion rather than reason. We have heard all this talk of impending crises before, and

yet nothing appeared to happen. The Government ought to do something about it. Something will turn up before long. Anyway, what can I do about it that is likely to make any difference?

The problem of increasing productivity is, therefore, as much psychological as economic. It is the problem of "we" and "they" and are we not doing quite nicely as things are? Never before in the whole of our industrial history have so many people been so well off or have so few people been unemployed. In spite of high prices we still have something to spare on TV and radio sets and alcohol and, in addition, an average weekly expenditure of the population of 4/- on football pools and betting and 7/- on tobacco.

In spite of a shorter statutory working week, are we not having to work overtime in the majority of industries? How, then, can all this add up to an economic crisis?

While all of us tend to compare the present with the past — and in this fact perhaps lies our danger — it is the job of those who manage industry, and the government of the day, to watch trends and to compare the present with the future in the light of what our competitors are doing.

If all the world is demanding foodstuffs and raw materials then the world level of those prices may exceed the level of prices for our manufactures and, in consequence, the terms of trade turn against us. To get the balance right, we must export more manufactured goods for the same imported amount of food and raw materials. Moreover, all those countries with whom we trade must have confidence in our economic stability as a creditor and in our production efficiency as a supplier of the right goods, at the right price, and delivered at the right time.

At home, while more goods are being produced than ever before, until now, these have largely been consumed by the home market, which means that in many cases we have been importing raw materials to manufacture goods which we have not exported. In consequence, this has not helped to buy the raw materials from abroad which are essential if we are to keep our industry running at a sufficiently high level of capacity to maintain the full employment to which all political parties are committed. In addition, we have a mounting liability through an ageing population. In another twenty years or so, one person in every five of the total population will qualify for the Old Age Pension. The National Insurance Fund is already beginning to outstrip itself and it is estimated there will be a deficit of £400 million by 1975 at the current rate of contribution and benefit. Whether we like it or not, social services can only be paid for out of taxation and taxation can only be reduced by higher productivity on the part of all those engaged in industry. These are the facts.

Our present monetary difficulties, therefore, arise very largely out of the problem of maintaining full employment while preventing a rise in the cost of living. We have now reached the point when any increase in our standard of life will most certainly not come about by higher wages, which would result in pricing ourselves out of the world's markets with consequent mass unemployment, but only by a reduction in costs, and prices, which will not only increase the purchasing value of the pound but, by the same token, benefit the whole community and, by no means least, all those with fixed incomes such as the widow, the pensioner, and the disabled.

This can only be achieved by higher productivity or, in other words, producing more with the same labour force, plant, and facilities, as are now available.

**Psychological Factors — When You Raise Productivity You Raise Hell**

We have always had a genius for finding alibis for our failings. In the past, management blamed labour, labour blamed management, and both blamed foreign competition. The fact remains, however, that other countries, including the so called underdeveloped countries, are making every effort to secure the highest standard of life for their own people — and they mean to get it with all the techniques which are available for making the maximum utilisation of their manpower, machines, and materials.

As for ourselves, we like to think we are pretty good and, unless we thought of the new idea ourselves, it cannot be worth much. Anyway, even if the idea is good, it does not apply to us because our job is different!

While we are all for the application of these new techniques—to someone else's job—our own presents special difficulties which are outside their scope.

"We are an old-established industry founded on traditions of craft and skill which cannot be found anywhere else and certainly cannot be measured." "We are only a small jobbing shop, most of our work is one-off and detailed drawings are not available." "We are a continuous process industry and get all sorts of variations in plant, processes, and raw materials, and it is impossible to say where one man's job starts or finishes." "There is a lot of mental attention and responsibility, rather than physical effort, in our job."

Whatever the alibi, one thing is always certain. Our job is different!

Of course it is. No two jobs are ever quite the same. Even in the same industry. Anyway, people are different.

An even better alibi, however, is to say that while you agree with all these techniques you, yourself, have been practising them for years. This is a really good stand-by to have up your sleeve because it puts the other man in the almost impossible position of having to tell you that you are not practising these things. And he has to do this without giving offence!

Work Study, which is largely the critical application of common sense–the most uncommon thing there is—can be applied to any job of work, for it is based on fundamental principles the object of which is to take work out of work. The truth of the matter is, of course, that we dislike change but this resistance to change does not necessarily arise from the same motives on the part of all those engaged in industry. The objections already mentioned are obviously more

common to managements than workers and emanate from a sense of fear of the consequences of change upon a supervisor's position and status within his own organisation. After all, if productivity is increased, by action taken by someone outside the supervisor's own department, the supervisor may well have a natural fear that higher management will ask him what he has been doing all these past years!

While the function of Work Study is to show how much better things could be, rather than how bad they are, there is, at the same time, no disgrace in doing badly—providing we know why we are doing badly, and to what extent. We must however get away from this, almost national, trait of ours by which we love to apportion blame for things past. This will get us nowhere.

The objections raised by those on the shop floor are much easier to recognise and, in some ways, easier to answer. In the first place there is the very natural fear of redundancy, "Shall I work myself out of a job?" This question has been answered in detail by the British Productivity Council's recent publication "Productivity and Redundancy" (Action Pamphlet No. 6). It shows that whether there is redundancy or not depends very largely on planning by management to avoid it. To apply Work Study properly takes time and, if recruitment is stopped, or reduced, prior to its application, this will usually take care of any redundancy. After all, the present annual labour turnover in industry exceeds 20%. While, as we know, this does not mean the whole labour force is changed every 5 years, it does mean there is a 'level' of employees in industry who come and go for a variety of reasons. In the writer's experience, he has not yet seen any application of Work Study likely to reveal an immediate redundancy figure of this order. Moreover, of course, the foregoing assumes there is a limitation of plant capacity so that the existing labour force could not produce more. In many cases this is not so and the higher output—at reduced costs—has meant that a company has been able to reduce prices and thereby increase sales. As a result they have had to increase their labour force. To take the attitude that slower working safeguards jobs, means an increase in labour costs, selling prices and, eventually, mass unemployment.

The other factor which has a direct bearing on the question "Will Work Study lead to redundancy?" is the considerable amount of what might be termed "organised overtime" being worked in industry today. While it is agreed that some jobs, such as maintenance, necessitate overtime working, this does not account for the excessive overtime being worked at the present time. The truth of the matter it that, in many cases, overtime is being worked simply to enhance gross wages and thereby attract and retain labour in a period of full employment. It is not without significance that the majority of firms adopting this expedient are those who have not applied incentive schemes based on Work Measurement and whose workers are, in consequence, on plain time rates.

On the other hand if, by better planning and organisation, and the application of sound incentive schemes, it is possible to get through the same amount of work during the statutory working period and the workers are no worse off—particularly bearing in mind they can enjoy their week-end leisure—then a material saving in the overhead costs of industry will have been achieved.

Overtime working is rarely economic, in the best circumstances, for the worker is receiving the highest rates of pay when he is most tired. As it is, in many industries, basic rates of pay bear little relationship to gross earnings and this fact is tending to obscure the real issues in negotiations between employers and trade unions. Any increase awarded, and however well deserved, can only widen the differential in gross earnings within a particular industry as between those on overtime and those not. In trying to solve one problem we have created others simply because we have not faced up to the fundamental issue of relating wages to productivity.

This fear of redundancy has been dealt with at some length because it is, perhaps, the most important. There are other objections, of course, such as suspicion of the methods used to assess work or even, as one man once said when asked his objection, "You're going to find out how little I do!" At least, it was a fair comment and should be respected as such. People don't slack for the fun of it. In fact they will go to endless time and trouble to avoid working — and become quite exhausted by the effort—if they work for a management which no longer knows how to manage.

The foregoing objections are not, of course, directed to Work Study alone but they have been enumerated because they are typical of the points likely to be raised prior to its application. As someone said to the writer when he was in Holland recently, "When you raise productivity, you raise Hell." The degree of "hellishness" depends, of course, upon the degree of consultation which takes place at all levels, for if you don't give people the facts, they will guess. Usually, they will guess wrong and the wise management will take its employees into its confidence *before* the application of production techniques which are likely to affect them and not *after* they have been applied, and queries have arisen.

**How Productivity can be Increased**

In the main, there are three ways by which productivity can be increased.

The first, and apparently obvious, way is by means of new plant and equipment but this line of thought is not quite as simple as it appears. New plant, and equipment, takes time between the placing of the order and its delivery and any company thinking along these lines would have to be confident of the market for its products by the time the plant was ready. Moreover, the current restriction of credit, together with the high rate of taxation of industry, both tend to discourage new capital projects. A further, and important point, as far as productivity is concerned is that while additional plant and workers will, presumably, increase *production*, they will not necessarily increase *productivity*. In fact,

the latter might actually go down. The reason for this is that production — output — is a measure of *quantity* whereas productivity — which is the ratio between what we get out to what we put in — is a measure of *quality* of effort.

A second line of approach is by means of simplifying processes and products and, in the former connection, attention is drawn to the recent publication of the Institution, "Materials Utilisation in the Metalworking Industries". This stresses the importance of the maximum utilisation of materials, through better design and processing. In this connection, it would be interesting to know how many firms work out the nett utilisation of materials in a finished part as a percentage of the total material ordered. Again, much can be done in the way of rationalisation once it is realised that variety production not only adds to the costs of manufacture but also to those of distribution.

The third way by which productivity can be increased, and the one which is the basis of this Paper, is simply by making the most of all the resources we already possess by better planning and organisation. In other words, by better management ; by knowing what we want people to do and by seeing that they do it in the best possible way.

**Work Study — Facts Plus Thought**

This attitude of mind constitutes the fundamental approach to Work Study which is not Time Study, nor Motion Study, nor Incentives, nor any one of these things on their own but, rather, the study of the whole job in relationship to the whole man.

If the layout of the job is poor, or workers not properly trained, no incentive scheme in the world will rectify these deficiencies. "Like oats for a horse, they will not change the breed." By the same token, no useful purpose can be served by measuring the amount of effort required to perform a job being done in an inefficient manner. As an analogy, if we want to know how long it will take to travel from one place to another we must first know the route to be followed and the method of transport. Time, on its own, is of little value. On the other hand, if we know all the facts regarding two different ways of doing the same job, the operations involved together with the movement of materials and personnel, we should also require the respective times in order to make an evaluation of relative costs.

In his book, "Work Study",* Mr. R. M. Currie, M.I.C.E., M.I.Mech.E., M.I.Prod.E., Head of the Central Work Study Department of Imperial Chemical Industries Ltd., shows that although many differing techniques are involved, they can all be classified under two main headings ; Method Study and Work Measurement.

Method Study is the detailed analysis of existing or proposed methods as a basis for improvements, whereas Work Measurement is defined as the determination of the proper time to be allowed for the effective performance of a specified task. It will be apparent, therefore, that, although they are two different functions, Method Study and Work Measurement are complementary techniques. There can be no such thing as a Standard Time for any job unless there is, first of all, a Standard Method. Neither, of course, can there be a Standard Cost.

As the term implies, Method Study seeks to find the one best way of performing any given job. All too often we rely on inspiration to improve methods whereas perspiration would yield a better result. Few methods in industry are so bad that their faults "hit you in the eye" and, in a flash, you get the answer. More often than not, however, it is possible to make minor alterations and improvements which are not apparent from superficial examination.

Method Study, which is largely the ordered application of commonsense, should be carried out in the following sequence :

*First.* Select the job to be studied, bearing in mind the possible results which may accrue from any improvement. For instance, it is as well to choose a job where an improvement is likely to affect a large number of workers or, alternatively, will be reflected in increased output. It is equally essential to ensure that the job selected is not likely to be affected by a change in programme at a comparatively early date.

*Second.* Record all the facts regarding the present method. Do not write them down from memory but on the job. In this way the error of describing how you think a job is done, or ought to be done, will be avoided.

*Third.* Examine each of the facts recorded. Why is it done that way ? Is there a better way ? Who does the operation and is he properly trained to do it ? Why is the operation carried out at that stage and in that part of the factory ? This questioning sequence can be greatly amplified, beyond the scope given here, which merely serves to show the analytical and critical approach which is the starting point in any form of increased industrial efficiency.

*Fourth.* Develop the new method. As stated earlier, one of the 'key' points in method study is in getting at the facts. While we may be aware of the existence of a problem, we shall never solve it until we really know its content. Once this is known, the solution is in sight. Indeed, there may be a number of alternative improvements and each may have to be evaluated in the light of all contingent circumstances such as the availability of plant and equipment and expenditure. No new method should be adopted simply because it *looks* better but rather because it can be *proved* to be better.

*Fifth.* Install the new method as standard practice. To apply any new method is never as easy as it may at first appear. If the new method of operation is to be maintained in practice, it can only be so if the operator himself *believes* it is better than

* "Work Study." Production Management Series 2. Published by the British Institute of Management. Price 3s. 6d.

the old. It is essential, therefore, to explain to him the faults in the old method and the reasons for the new.

*Sixth.* Maintain the new method. It is not sufficient to devise a new method and leave it at that. The improved method must be clearly specified and checked from time to time. Otherwise, it will most surely alter. Not drastically, so that the alteration can be spotted, but in small ways over a period of time and, because of this, the changes become imperceptible except to those who have been away from the job and come back after a while and can see the difference.

Method Study, perhaps more than any other technique, demands consultation, and trust, if it is to succeed in its purpose. All of us have a pride in our craftsmanship and do not always like to be told by someone else that what we are doing, and the way in which we are doing it, is inefficient. While it may be agreed that the best person to improve a job is the operator himself, familiarity with all its aspects had probably led him to take its faults for granted! This being so, management has a special duty to discharge in getting people to think about their jobs, however long they may have been doing them and, also, in getting them to look at the old problems in a new way. Nothing must be taken for granted. Everything must be questioned. Above all, there must be a willingness to accept new ways without preconceived ideas to prejudice them in any way.

There is an enormous amount of latent talent waiting to be tapped in British industry today. People no longer come to work — only. They come to think as well. However, they will only do these things if they are encouraged to do so by management. How many suggestion schemes are really satisfactory ? Very few. Suggestions about the time of buses, meals in the canteen, or the recreation club, do not produce more goods in measurable quantity. And the primary job of industry is to produce.

The reason for this unsatisfactory situation lies at the door of both management and workers. How many managements, when a suggestion is made, take the time and trouble to *cost out* the value per annum of an idea for improvement submitted by their employees ?

On the workers' side, many suggestions for improvement are lost simply because insufficient thought is given to collating all the relevant facts appertaining to a new method when compared with an existing one. How many operations can be saved ? Will the distances involved in transporting materials or labour be reduced ? Finally, how long will the new method take and, because time is money, how much will be saved ?

When these facts — and not opinions — are known, the new method will be sold. Management cannot afford not to 'buy' it.

It will be noted, from the foregoing, that mention has been made of time as the basis of labour cost. As a corollary, if the time required to perform a specified task is known, it is also possible to determine the number of personnel required to produce a specific output — or to forecast the output from the personnel available. Time, therefore, is the basis for cost control and labour planning, and, if such times are to have value, it is essential that they should be as nearly accurate as possible. This desire for accuracy in the setting of times for industrial tasks is the object of and justification for Work Measurement. The alternatives are all within the realm of guesswork.

Work Measurement comprises two angles of approach. Time Study for repetitive work and synthesis from elemental data, or analytical estimating, for non-repetitive work. These techniques are not discussed in this Paper as they have been most adequately dealt with in the British Institute of Management publication to which reference has been made earlier. The main point of interest for industry is that, between them, they have demonstrated the almost universal application of Work Measurement over a whole field of operations which, until recently, had been thought incapable of any form of accurate work load assessment, such as plant maintenance, continuous process operations and clerical work.

The result of this is that managements have been provided with data upon which they can forecast reliable performance indices, either for the individual or for whole groups of workers. It is possible to determine the magnitude of, and reasons for, excess costs and, where Method Study and Work Measurement are used at the design stage, it is possible to determine not only how work should be performed but how long it should take. This last should be a fundamental concept in the mind of managements who contemplate the erection of new plant or installing new processes. It is infinitely preferable to the traditional methods of saturating a new job with labour and then having to displace personnel at a later date on the introduction of Work Study. Indeed, such a procedure is one of the main reasons for bringing Work Study into disrepute.

Work Study is, therefore, a tool of management and it is up to management to check whether it is going to be used wisely with all those concerned — with supervisors and workers — being kept fully acquainted with its implications, or recklessly, with all the ensuing problems of bad faith and suspicion. It is not sufficient to say "This is the answer and don't ask me how I got it". We must be prepared to say "This is the job as it was seen, these are the methods of assessment, and these are the facts". Work Study is fact plus thought. In the ideal instance you do not impose it, you become part of it.

**What is there in Higher Productivity for Me ?**

This may appear a cynical question but it is one, nevertheless, which must be answered for the results of higher productivity must be real and tangible. For the whole population a reduction in costs and prices would mean the best rise in real wages which any of us could get, but what about those taking part in achieving higher productivity ? In this connection there are a number of interests to be met which, though different, are all reconcilable. For the firm itself, there is the need for constant re-equipment

so that it can keep up to date. In addition, its financial reserves must be maintained as a safeguard for the future. Also its shareholders are entitled to a return on the capital invested without which the firm would not be in existence.

As regards those employed by the company, it is the writer's belief that the full benefits of Work Study will only be achieved when they are associated with an incentive scheme. While this is not the occasion to enter into a discussion on the merits of different types of incentive schemes, for the question is complex and controversial and a matter of management policy, the problem as a whole is relevant when discussing the various facets of higher productivity.

At the same time, it must be realised that incentives are not the panacea for all industrial ills and, where incentive schemes have failed in the past is not so much because our conception of incentives was wrong, as due to the fact that those who devised the schemes in the first place had not taken sufficient time or trouble to work out the basic conditions which alone can ensure success.

While mention has been made of Work Measurement as the basis for labour cost control and planning, it can equally be used as the basis for incentives. At the same time, it should be understood that setting a time for a job is different from setting a monetary rate for it and, in this connection, it is stressed that the negotiation of rates is within the traditional role of managements and trades unions. In these negotiations, however, it can be said that the results of Work Measurement replace opinion by fact. Moreover, if an incentive scheme is to operate satisfactorily, it can only do so within the framework of certain conditions which are fundamental to good management/employee relations.

The methods used, plant, and equipment, must be specified in relationship to the bonus rates — and these last must be guaranteed as long as the former conditions remain unchanged.

Both supervision and workers must fully understand how the bonus rates have been determined and the method of bonus computation.

Standards of quality must be determined *before* the scheme is applied and their maintenance made a condition of bonus payment.

These are only a few of many conditions which may be "written into" a bonus scheme, but they serve to emphasise the need on the part of managements to give close thought and consideration to the planning of such schemes and for having a policy in connection with their administration. In this latter connection, it must be realised that, as soon as the first bonus scheme has been applied and to however small a number of workers, differentials in gross earnings as between one class of workers and another throughout the factory will have been upset.

It is not sufficient to select the simple repetitive day work job and apply a bonus unless management has also given thought to the continuous process shift job, and the maintenance job, etc. — to mention only a few.

Above all, it should be realised that no incentive scheme, however good, can be a substitute for good management.

Under incentive schemes, people do not generally work any harder than before. They tend to work *continuously* rather than *intermittently* and thereby cut out idle time which, prior to the inception of the scheme, was the fault of the worker. In this way the overall effectiveness of the employee is raised. Within this context, however, management also has its part to play in ensuring that there is an adequate 'head' of raw materials, in having eliminated bottlenecks in manufacture and in having made adequate shipping arrangements to dispose of the finished products.

It will be seen, therefore, that in these conditions the role of supervision is one of advisor and planner and controller of quality. What it should have been in the first place!

While it may be argued that incentives need not necessarily be financial, the objective remains the same. To differentiate between the good and the not-so-good and encourage both to give their best.

**Work Study — Appreciation and Training**

No discussion would be complete without some reference to the problems of training and education in this field. Work Study has become 'news' and, while this development is to be welcomed, it also raises many potential dangers and problems; the danger emanating from the inexperienced practitioner; the problem of both higher management and workers' representatives not being fully acquainted with the implications of Work Study. There would appear, therefore, to be an urgent need for several different types of courses for different levels in industry.

Briefly, these courses would cover the following needs:

Appreciation courses for both supervision and workers within the firm itself, preferably before the application of Work Study.

Appreciation and, if necessary, training courses for trades unions officials. In this connection, many individual unions have taken the most active steps — and spent large sums of money — in ensuring their officials are adequately trained so that they may advise their members. In addition, the Trades Union Congress has, for some years, run courses at its Production Centre and these have been consistently well supported by officials from the various affiliated unions.

There is also a need for both Training and Appreciation courses on an industry basis, particularly where such an industry is composed of comparatively small manufacturing units which have not the facilities, within themselves, for this type of educational work. The Engineering and Allied Employers' West of England Association, and the Wool and Allied Textile Employers Council, are two instances of industries taking active steps to work out their own salvation in this field for both have set up Work Study Schools with striking success. This success is due, in part, to the close liaison between the staff of the centres and the student when the latter returns

to his firm. For however much theoretical training is given, practical training really starts on the job when the student says "What do I do now?". And you tell him.

Many technical colleges are already doing valuable work in the general field of appreciation though, of necessity, these courses must be based on Method Study rather than Work Measurement. Again, in this field, there is considerable scope for the introduction of an appreciation of Work Study into existing courses — particularly those dealing with the physical sciences.

Perhaps more important than any other aspect at the present time is the need for a continuing interchange of information among those already practising Work Study. This is essential if the considerable progress which has been made within the past few years is to be consolidated and the technological institutions are to be provided with a firm foundation for teaching in the future.

**The Promise of Productivity**

We are only just beginning to understand the meaning of "productivity", to measure differences, and to assess their causes. At the same time, higher productivity can never be an end in itself but, rather, a means to an end by which we may enjoy not only a better standard of living but, also, a happier life.

With the development and extension of all forms of mechanisation and automation, the proportion of leisure time to working time will increase and man's fulfilment of himself will depend on both his spiritual and material progress going forward together. The industrial revolution of the 19th century has given place to a state of evolution in the 20th, and the process is not yet complete. At the same time, it would be completely erroneous to believe that work will ever be abolished. Man will always be master of the machine and, while physical work will decrease, mental attention and responsibility will increase and it is not without significance that, throughout the world, those people who do the hardest physical work suffer the lowest standard of life and, conversely, those operating machines or maintaining them, are better off.

In effect, this means that we must be prepared to face up to the challenge of change. To learn new skills, to change our attitude of mind if need be, and to question everything, and even to change our place of work. Naturally, few of us like to do these things but — in the final analysis, there is no choice and no compromise. Either we move with the times — and our competitors — or we shall go under.

All our industrial history goes to prove that technological progress has never resulted in overall unemployment which is caused by economic factors often quite outside our control. At the present time, full employment is a world phenomena largely caused by the late war and a continuing expenditure on arms. It is nothing that we have earned. On the other hand, it is something that we have a chance of maintaining if we have the courage and the wisdom to paddle our own canoe rather than ride on the crest of the wave.

This means that we must take effective action *now* and, for this reason, the British Productivity Council have stated their emphatic belief that Work Study is a means by which productivity can be increased within a short space of time and with little or no capital expenditure. While no one can guarantee full employment, a high state of efficiency within British industry does mean that we have an infinitely better chance of survival in periods of unemployment — and that the unemployed can be paid!

Are we prepared to accept this challenge? As Graham Hutton said recently, industry can be the most exciting and romantic thing in the world. It presents a perpetual challenge to our skill, ambition, and inventive genius. These are the fabric of our industrial life. They are our greatest asset which, for generations, we have exported. Upon whether we now use them, at all levels in industry, will depend the promise of productivity.

With each new technological discovery, the frontiers of science recede a little further but the need for wisdom remains. Knowledge, of itself, is not enough — it is how we use it that really matters.

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The September issue of the Journal will contain the remaining four Papers presented at the Production Conference, as follows:-

**"Investing in Better Materials Handling"** by K. Trickett, B.Sc.(Eng.).

**"Investing in Better Utilisation of Resources"** by Bertram White, B.Sc., F.R.I.C.

**"Investing in Education and Training"** by A. D. Bonham Carter.

**"Investing in Better Human Relations"** by Fred Hayday, T.U.C.

## old method

### CASE STUDY No. 5

**Handling to and from the Machine.**

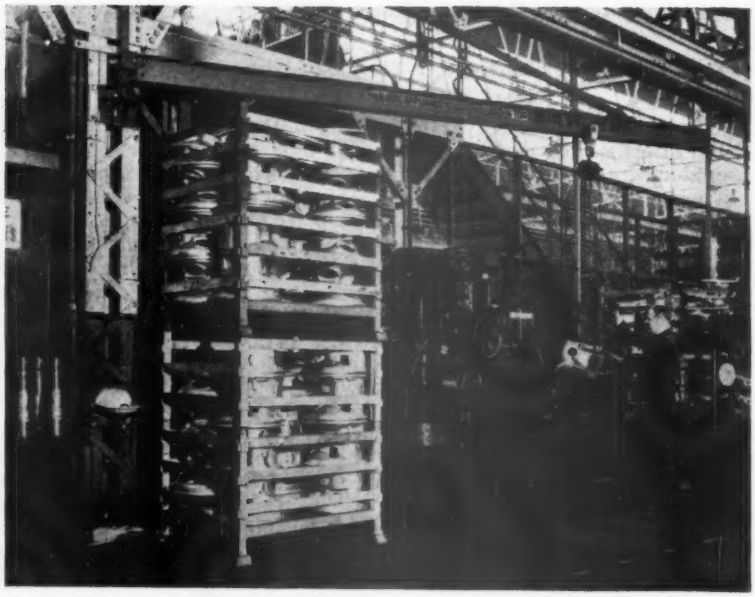
*Firm*: **Albion Motors Limited.**

*Author*: **W. P. Kirkwood.**

An example of materials handling — to and from the machine. Relatively heavy components in batch production.

**The Company.** *Manufacturers of commercial motor vehicles of the medium and heavier types. These are produced by batch production.*

**Circumstances.** *A large machine shop dealing with a variety of rather heavy components, machined in batches, the flow of material being dictated by the nature of each component and the necessary operations.*



*A small pulley block and trolley on an end pivoted channel was used to move components from stillages into and out of machines.*

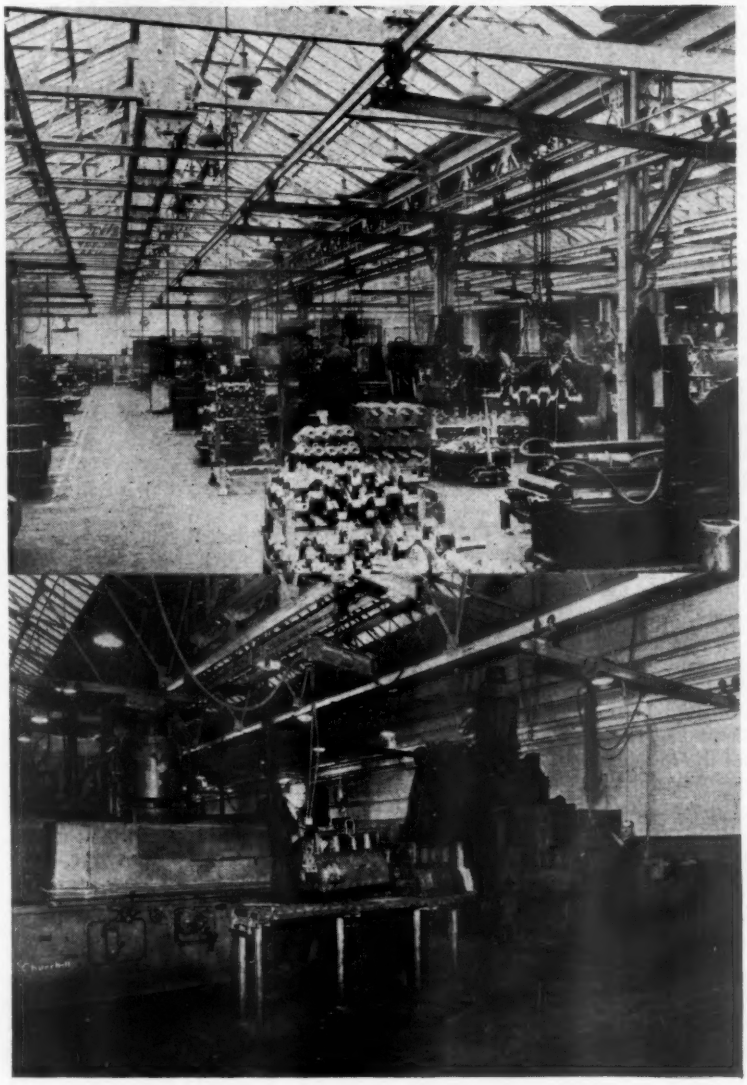
*The disadvantages of this method were :*

(a) *the area of coverage is limited and, therefore, inadequate, unless a heavy and expensive jib crane is additionally provided ;*

(b) *because the radius of crane coverage did not span all the machines, much manual labour was involved in handling work onto and from machines outside this area.*

S HANDLING

## new method



Simple parallel longitudinal tracks are placed down the entire length of the shop under the machine bays spanning machines and gangways.

Short lengths of tracks with trolleys at either end are arranged to run at right angles to the parallel tracks; these short lengths carry a simple hoist lifting gear capable of traversing the short length. The lifting gear may be hand, electric or air, and this means that the job can be lifted from the stillages directly onto the machines and from operation to operation for quite a limited expense in capital outlay. Furthermore, the machines can be altered or rearranged without interfering with the materials handling.

## Education Discussion Group Meeting

The Institution's Education Discussion Group, London Centre, will hold a meeting at 10 Chesterfield Street, London, W.1, on the morning of Saturday, 8th September, 1956, in order to discuss the subject of machine tools as it applies to the Syllabus of the Institution's Examinations.

The meeting will commence at 10.30 a.m., and will be concluded at 1 p.m.

Mr. C. T. Bower, Honorary Secretary of the Group, would be pleased to welcome to this meeting any members of the Institution who are interested in education.

## Obituary

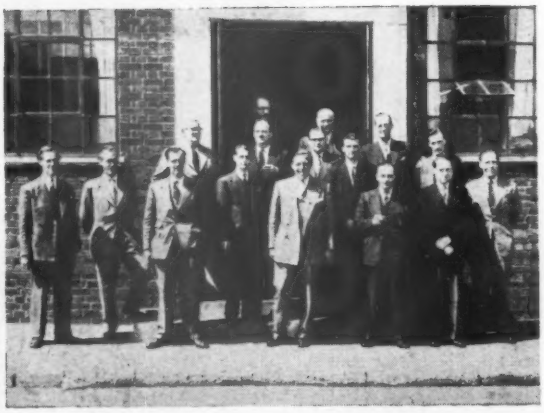
The Institution records with deep regret the death of Mr. W. P. Eastwood, Member, Managing Director of George Swift & Sons, Ltd., and of Swift-Summerskill, Ltd., and of Modern Foundries, Ltd.

Mr. Eastwood was a founder member and the first President of the Halifax Section, which was established in 1944, and he served continuously on the Section Committee from 1944 until his death. He also played a very active part in the formation of the Production Engineering Research Association of Great Britain and was closely associated with its work.

**Mr. Eastwood**

Among his many other activities he was a member of the Council of the Machine Tool Trades Association and the Machine Tool Trades Advisory Council to the Ministry of Supply. He was also a member of the Executive Council of the Foremen's Mutual Benefit Society and an employer's representative on the West Riding Regional Board for Industry.

Known simply as "Pat" to his wide circle of friends and business associates, he was liked and respected by all who had the privilege to work with him. He served the Institution with unfailing loyalty and enthusiasm for a great many years, and his loss will be keenly felt, particularly among his colleagues in the Halifax Section.



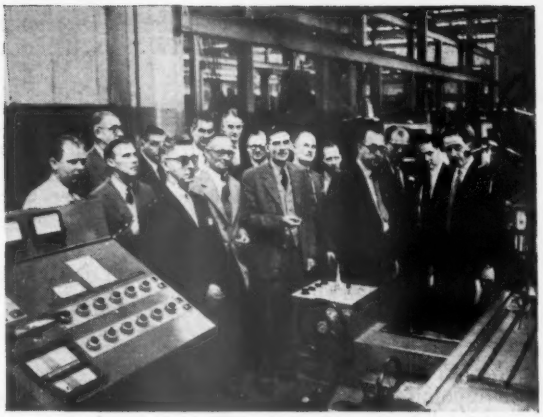
**On 15th May last, the Materials Handling Sub-Committee of the Institution spent the day at the works of AC-Delco, Dunstable. It was a most interesting visit, and the Sub-Committee greatly appreciated the Company's hospitality. This photograph was taken outside the works, and shows members of the Sub-Committee with the Chairman, Mr. A. G. Hayek *(centre)*.**

## New Director For B.I.M.

The Council of the British Institute of Management announces the appointment of Mr. F. R. Livock, T.D., B.Sc.(Eng.), M.I.E.E., M.I.Mech.E., as Director of the Institute. He succeeds the Honorary L. O. Russell, who resigned as Director last December.

Mr. Livock was educated at Berkhamsted and University College, London, and after graduating in electrical engineering, he served a College Apprenticeship with the Metropolitan Vickers Electrical Co. Ltd., and was subsequently employed on their technical staff. In 1933 he joined the sales organisation of the General Electric Company in Manchester. From 1939 to 1945 he served with R.E.M.E., and was demobilised with the rank of Lieutenant-Colonel. He was subsequently appointed Controller of Education and Personnel Services to the G.E.C. He joined Metal Industries Ltd., in 1953, and has served on the board on three engineering companies in the Metal Industries Group.

**The North Midland Regional One-Day Conference, held at Peterborough on 2nd June, 1956, was most successful. A number of visits to engineering works were arranged, and this photograph *(right)* shows a party of members at The Newall Engineering Company, Ltd.**



# news of members

**Mr. H. E. J. Butler,** Member, has been elected National Chairman of The Association of Supervising Electrical Engineers. Mr. Butler joined the Association in 1933 and was elected Secretary of the North-West London Branch in 1948. He was elected Branch Chairman the following year and was elected to the Executive Council of the Association in 1954. He is well known to members for his lectures at branches on "Electrical Resistance Welding" and the "History of Electrical Engineering". His initial practical training in optical and electrical instrument making at a well-known firm was followed by further shop experience as wireman, electrical inspector and tool-maker. This was followed by progressive appointments as Foreman, Production Engineer and Chief Engineer. He was recently appointed a Divisional Manager of his present firm, Messrs. Associated Automation.

**Mr. Butler**

**Mr. Albert Gaunt,** Member, who was at one time employed with The Mendip Engineering Company, has had to give up all active work in industry owing to a serious illness.

**Mr. H. Gladney,** Member, has been appointed Chief Tool and Plant Engineer to Ferranti Limited, Hollinwood, Lancashire.

**Mr. S. R. Howes,** O.B.E., Member, has retired as Director and General Manager of Samuel Fox and Company Limited, and has been appointed a Director of The United Steel Companies, Limited. Mr. Howes has also agreed to serve for a further three years as consultant for work study and operational research. Mr. Howes serves on the Committee of the Sheffield Section, of which he is a Past President.

**Lt.-Col. A. W. Page,** M.B.E., Member, who has been London Office Manager for the Igranic Electric Company Limited for some few years past, has been appointed Sales Manager of the Company and will operate from the Head Office at Bedford.

**Mr. Page**

**Mr. J. W. Taylor,** Member, has relinquished his position as Chief Jig and Tool Designer to Folland Aircraft Limited, to take up the position of Shop Layout Engineer with the same Company. Mr. Taylor was Chief Jig and Tool Designer for 15 years and was originally a marine engineer apprentice with the Wallsend Slipway & Engineering Co. Ltd. Mr. Taylor, besides being Honorary Secretary of the Southern Section, is also Honorary Secretary and Treasurer for the Southern Region and is a member of Southampton and District Productivity Committee.

**Mr. H. J. Ping,** Member, has become a Director of G. Dingwall & Son Limited, of Peckham, London.

**Mr. W. C. Toll,** Member, has relinquished his position as Superintendent at The Standard Motor Co. Ltd., Canley, Coventry, and has taken up an appointment with the Rootes Group as Production Manager at the Dunstable plant of Commer Cars Limited.

**Mr. F. A. Bailey,** Associate Member, Engineering Controller, Hadfields Limited, Sheffield, has been appointed Local Director.

**Mr. F. W. Bevis,** Associate Member, has taken up an appointment at the Tiverton Science Art and Technical School, Tiverton, Devon.

**Mr. R. A. Burden,** Associate Member, has relinquished his position of Works Manager, Mine Safety Appliances Company, Glasgow, to join Bristol Aircraft Limited, as Works Manager of the Cardiff factory.

**Mr. N. E. Cornish,** Associate Member, is now General Manager of W. H. Vowles and Sons Limited, Stonehouse, Gloucester, a subsidiary company of Wm. Butler & Co. (Bristol) Limited. Mr. Cornish was previously employed as a Consultant with L. W. Bailey & Partners.

**Mr. W. H. Crawshaw,** Associate Member, has relinquished his position with Rolls-Royce Limited, and is now Production Development Engineer with David Brown Industries Limited, Tractor Division.

**Mr. G. E. Greensmith,** Associate Member, is now Deputy Manager, Technical Survey, with Messrs. Louis Newmark Limited, Purley Way, Croydon, Surrey.

**Mr. H. Gurvick,** Associate Member, has recently relinquished his position as Technical Assistant to the Works Manager of Messrs. G. D. Peters & Co. Ltd., Windsor Works, Slough, in order to become a Member of the Advanced Planning Group of British Oxygen Engineering Limited, Edmonton.

**Mr. G. C. Fairbanks,** Associate Member, Group General Manager of Elliott Brothers (London) Limited, has been appointed to the Board of the Bristol Instrument Company.

**Mr. N. Herbert,** Associate Member, has taken up an appointment at the College of Technology, Chesterfield, as Lecturer in Production Engineering.

**Mr. J. Longden,** Associate Member, has taken up an appointment as Head of the Engineering Department of the Mid-Warwickshire College of Further Education, Leamington Spa.

**Mr. E. Roebuck,** Associate Member, has taken up an appointment as Gear Production Engineer with Borg-Warner Limited, Letchworth, Hertfordshire.

**Mr. G. Skinner,** Associate Member, has relinquished his appointment as Production Engineer, with the British Northrop Loom Company Limited, Blackburn, to take up an appointment as Production Manager with Messrs. Weston Evans & Co. Ltd., "Avanti" Works, Clifton, Manchester.

**Mr. J. J. Tobin,** M.B.E., Associate Member, has relinquished his position with Indian Iron & Steel Co. Ltd., West Bengal, and is now making a visit to the United Kingdom.

**Mr. L. Walmsley,** Associate Member, has taken up an appointment with Tubewrights Limited, Liverpool, as Production Engineer.

**Mr. B. J. Allen,** Graduate, has now taken up an appointment as Tool Designer with Airmec Limited, High Wycombe, Bucks.

**Mr. J. Isaacs,** Graduate, has now taken up an appointment with Automation Consultants and Associates, Limited, London.

**Mr. T. Mathew,** Graduate, has completed his training with Guest, Keen & Nettlefolds Limited, and is now taking up a position as Assistant to the Works Manager at Guest, Keen, Williams Limited in Bombay.

**Mr. P. W. Millyard,** Graduate, is now employed as a Planning Engineer by The English Electric Company Limited, Stevenage.

**Mr. D. Royston,** Graduate, who was previously a Production Engineer with The English Electric Company Limited, Luton, has recently taken up an appointment as Assistant Works Manager with Messrs. C. Baker of Holborn Limited, Croydon.

**Mr. R. C. Stubbs,** Graduate, has relinquished his position with The Plessey Company Limited, Ilford, and has recently taken up the position of Mechanical Design Engineer with Standard Telephones and Cables Limited, Footscray, Kent.

**Mr. W. A. J. Wilson,** Graduate, has recently taken up an appointment as Methods Engineer with Rotax Limited, Hemel Hempstead, Hertfordshire.

**Mr. R. G. Worrall,** Graduate, has relinquished his position as Work Study Engineer with the Philips Company, Mitcham Works Ltd., in order to take up a similar position with Standard Telephones and Cables Limited, Rectifier Division, Harlow.

# Hazleton Memorial Library

## ADDITIONS

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Bartho, F. T. and Pike, C. H. **" Factory Electrification."** *London, Macdonald,* 1956. 398 *pages. Illustrated. Diagrams.*

Board of Trade. **" The Report of the Census of Production for 1951."** Volume 3, Trade G Non-Ferrous Metals (Smelting Rolling, etc.) ; volume 3, Trade K (Aircraft Manufacture and Repair) ; volume 5, Trade A (Tool and Implement). *London, H.M.S.O.,* 1955. 22, 16 *and* 30 *pages.*

British Institute of Management, London. **" Outline of Work Study."** Part II, Method Study. *London, the Institute,* 1955. 72 *pages. Diagrams.* (Production Management Series 2b.)

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Geppinger, H. C. **" Dimensional Motion Times ; Development and Application."** *New York, Wiley; London, Chapman & Hall,* 1954. 100 *pages. Diagrams.*

Harper, L. J. (editor). **" Proceedings of the Second Work Study School Conference, Cranfield, 1955."** *Cranfield, College of Aeronautics,* 1955. 37 *pages.*

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Harper, John C. **" Profit-Sharing in Practice and Law."** *London, Sweet and Maxwell,* 1955. 368 *pages.*

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June, Stephen A. and others. **" The Automatic Factory: a Critical Examination."** *Pittsburgh, Instruments Publishing Co.,* 1955. 81 *pages. Illustrated. Diagrams.*

Kastener, L. J. **" A Century in the History of the Reciprocating Internal Combustion Engine."** *London, Institution of Mechanical Engineers,* 1955. *Pages* 303 - 312. *Illustrated. Diagrams.* (I.Mech.E. Proceedings, Volume 169, No. 15, 1955.)

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**" Machinery's Handbook for Machine Shop and Drafting Room."** (15th edition.) *New York, Industrial Press ; Brighton, Machinery Publishing Co.,* 1954. 1,911 *pages. Diagrams.*

Matthew, T. U. **" Productivity Measurement as an Aid to Management."** *Birmingham, University of Birmingham, Institute for Engineering Production.* 12 *pages. Diagrams.* (Executive Course Paper No. 5.)

Mayson, Christopher F. **" Law and the Engineer : the Law of Contract and Negligence as Affecting Engineers."** *Chapman & Hall,* 1955. 470 *pages.*

**" Metallurgical Abstracts : General and Non-Ferrous."** Vol. 21, 1953 - 1954 (New Series). *Institute of Metals,* 1954.

**" Metalworking Production — 150 Practical Ideas on Metalworking Production."** *McGraw-Hill for Metalworking Production,* 1955. 178 *pages. Diagrams.*

Morgan, G. A. W. **" Swiss-type Automatics."** *Brighton, Machinery Publishing Co.,* 1955. 3 *volumes. Illustrated. Diagrams.* (Yellow Back Series Nos. 36, 36a and 36b.)

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1956/57

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| **Sydney (New South Wales) ...** | A. Welsh, Room 802, 16 Barrack Street, Sydney, Australia. |

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| **Doncaster** ... ... ... | J. F. Spencer, 236 Warmsworth Road, Doncaster, Yorks. |
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*The early beehive ovens were heated by burning faggots inside. The embers were withdrawn when the baking temperature was reached, which was indicated when a flint, set in the oven wall, glowed a certain colour.*

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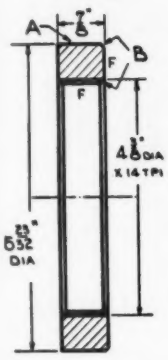
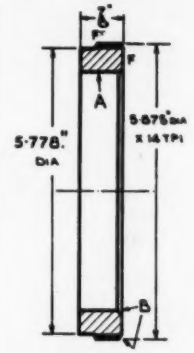


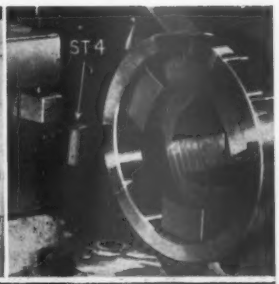

**Part No. 1**
Floor to Floor Time:
2½ minutes

| DESCRIPTION OF OPERATION | Tool Position | | Spindle Speed R.P.M. | Surface Speed Ft. per Min. | Feed Cuts per inch |
|---|---|---|---|---|---|
| | Hex. Turret | Cross-slide | | | |
| **Part No. 1** | | | | | |
| Chuck on A | — | — | — | — | — |
| Face End Size Bore and Chamfer B | 3 | S.T.1 | 416 | 620 | 133 |
| Screw Cut 4⅜" dia. × 14 T.P.I. (5 cuts) | — | Rear | 416 | 475 | 14 |
| Remove | — | — | — | — | — |
| **Part No. 2** | | | | | |
| Chuck Internally at A | — | — | — | — | — |
| Finish Turn 5⅞" dia., Chamfer B and Face End | 1 | S.T.1 | 416 | 640 | 133 |
| Turn 5·778" dia. | — | S.T.3 | 416 | 640 | 133 |
| Screw Cut 5⅞" dia. × 14 T.P.I. (5 cuts) | — | S.T.4 | 416 | 640 | 14 |
| Remove | — | — | — | — | — |

**LOCKING NUT** **SCREWED RING**




**Part No. 2**
Floor to Floor Time:
2½ minutes



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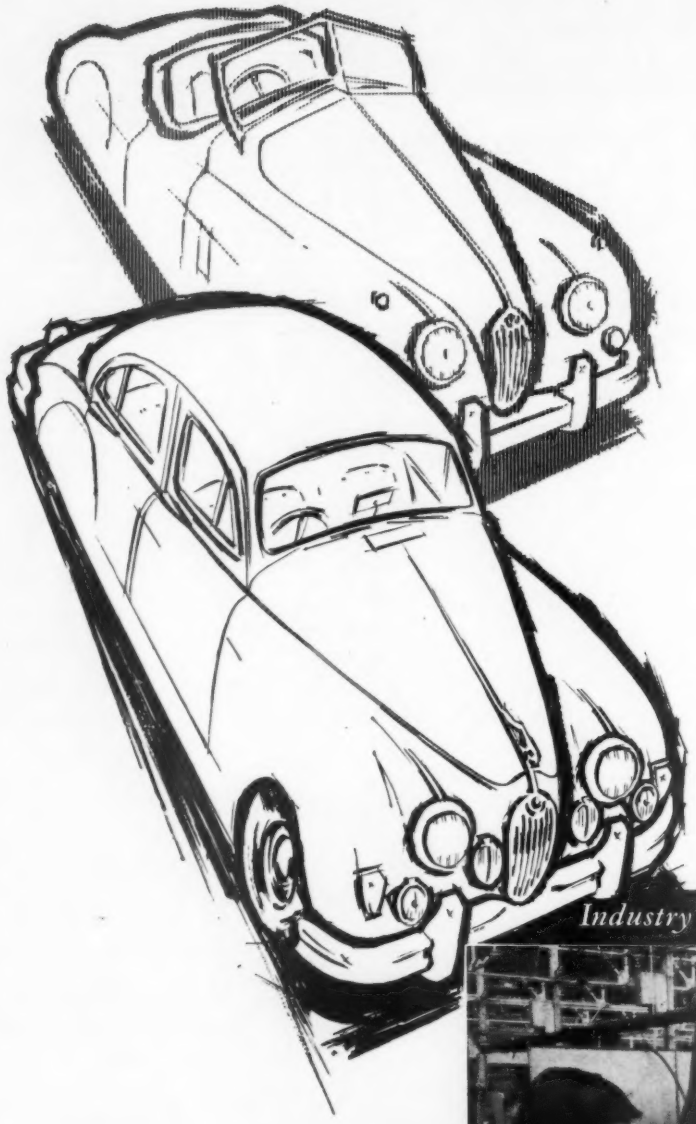

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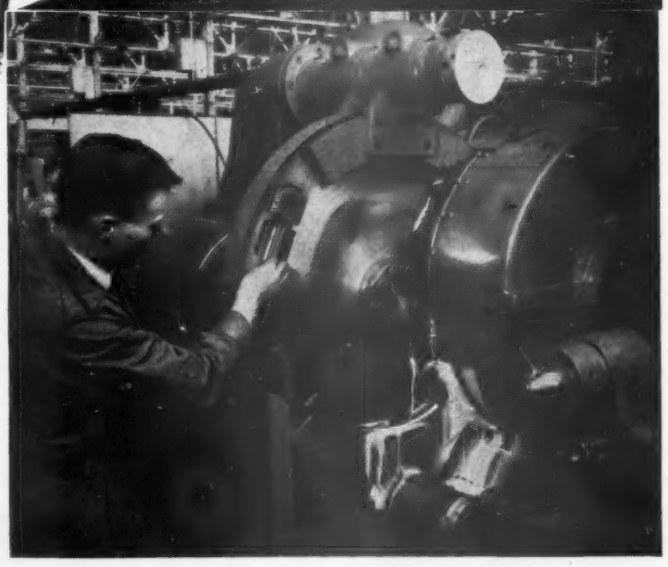
SURFACE SNOW GRINDERS

*Industry's biggest names use* **SNOW!**



By installing a Snow duplex disc grinder, Jaguar Cars Limited boost output of connecting rods to four per minute (a 900% increase).

*Photo by courtesy of Metalworking Production*

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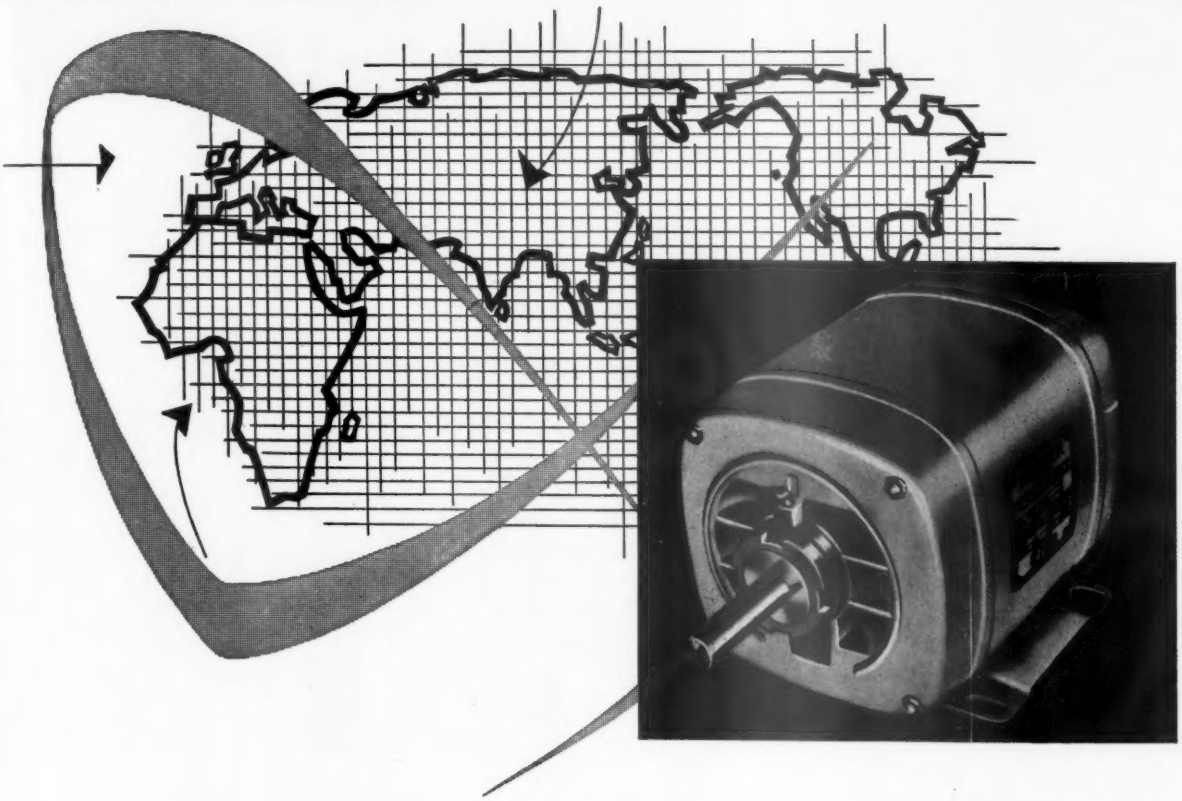

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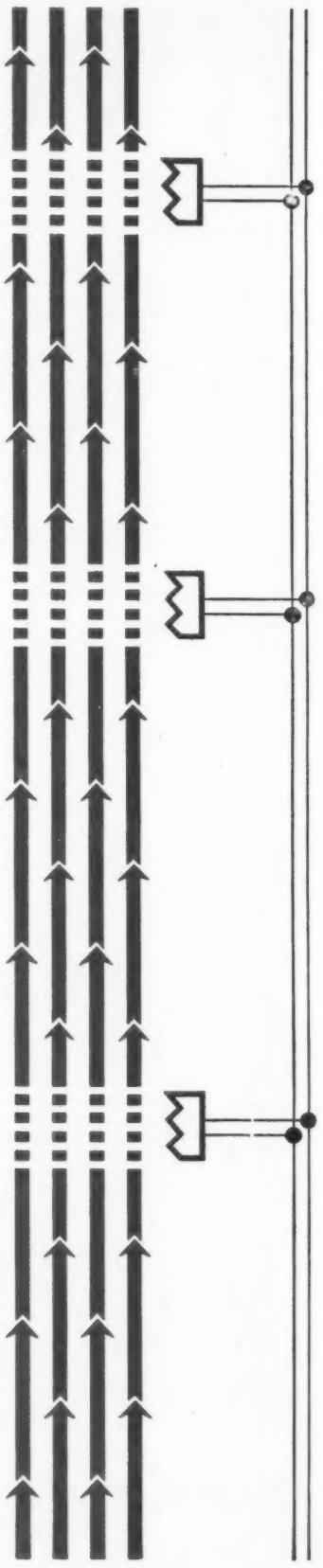
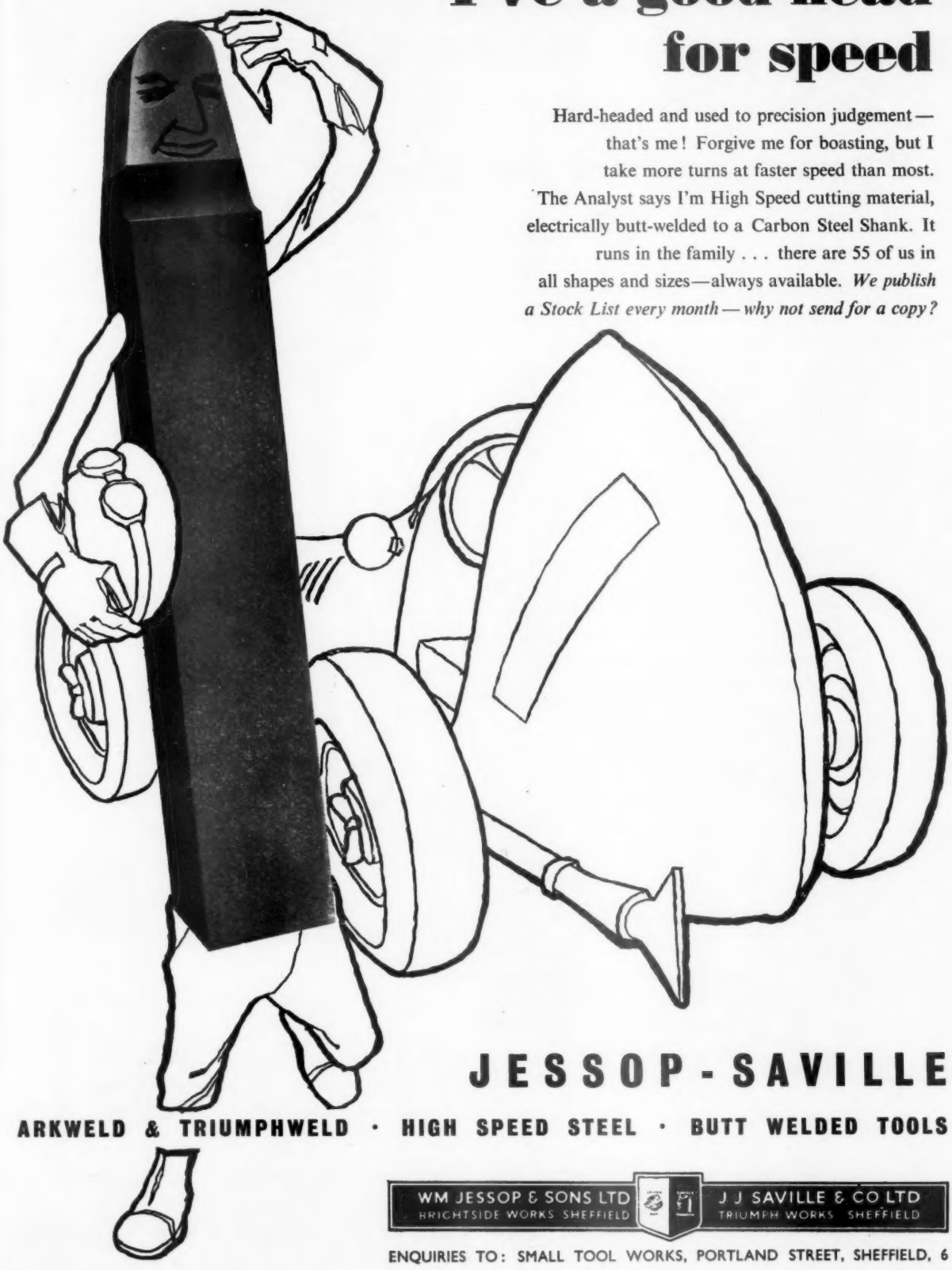


# I've a good head for speed



Hard-headed and used to precision judgement—that's me! Forgive me for boasting, but I take more turns at faster speed than most. The Analyst says I'm High Speed cutting material, electrically butt-welded to a Carbon Steel Shank. It runs in the family . . . there are 55 of us in all shapes and sizes—always available. *We publish a Stock List every month—why not send for a copy?*

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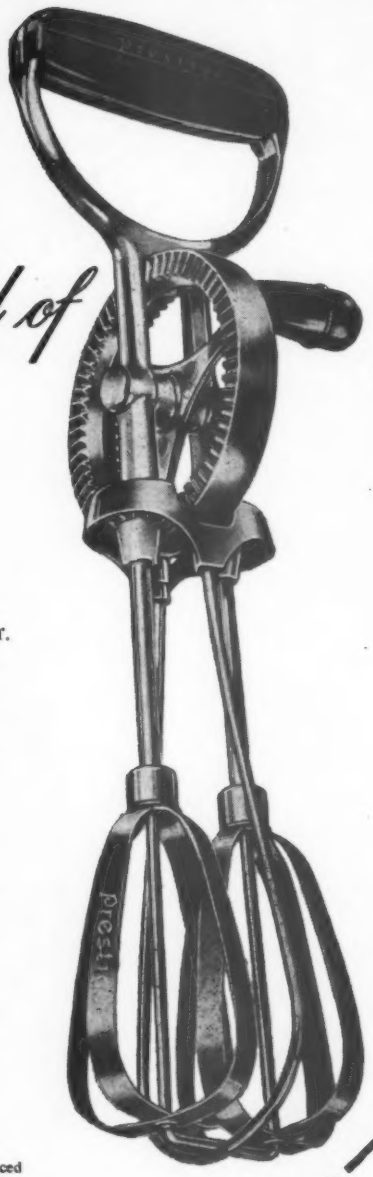


One of the most interesting features of the Prestige 'Imperial' Food Mixer, is that the makers give with it a five-year guarantee. We regard this guarantee as a fine tribute to the quality and prestige of our castings which form the body, handle and gear. Our reputation for quality and precision has brought its problems.

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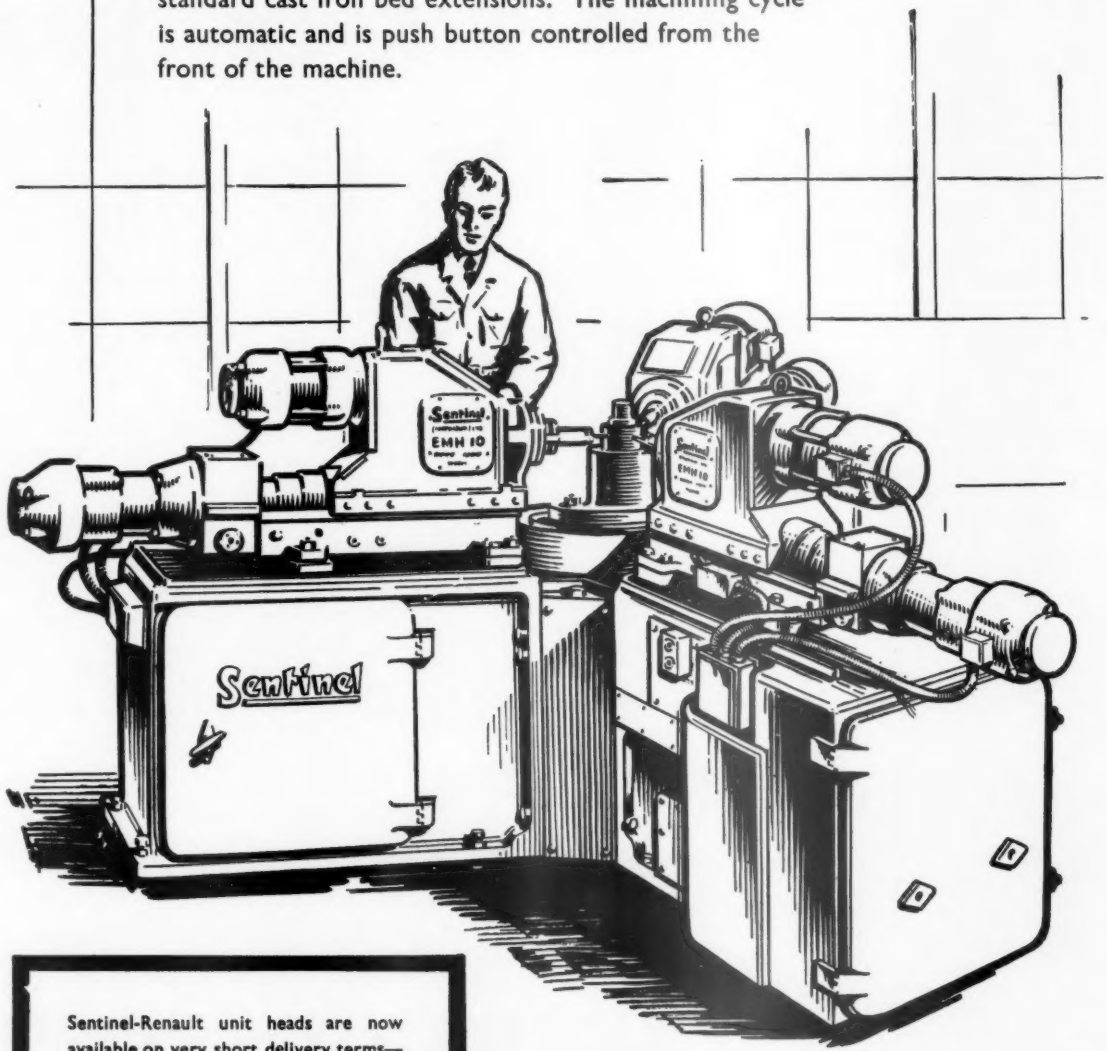
This machine is designed for the simultaneous drilling of three radially positioned holes. A fabricated steel base carries a central fixture, which holds the component for machining. The three Sentinel-Renault unit heads are mounted on standard cast iron bed extensions. The machining cycle is automatic and is push button controlled from the front of the machine.

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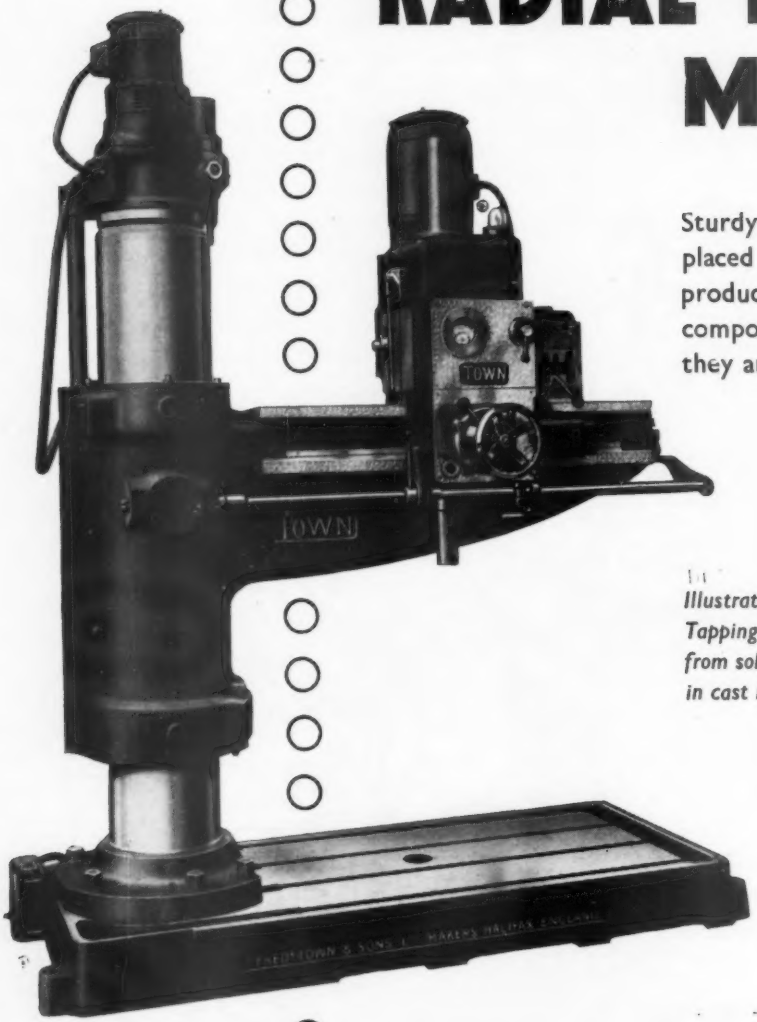
## RADIAL DRILLING MACHINES

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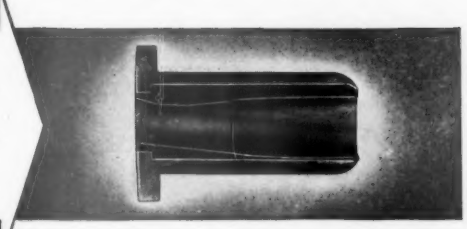
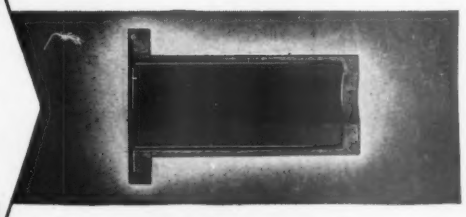
*The photographs below show the results of a comparative test made between a Tungsten Carbide Nozzle and a Carbon Tetra Boride Nozzle used with carborundum shot at an air pressure of 75-100 lbs per sq. inch.*

The $\frac{1}{16}$" bore Tungsten Carbide Nozzle was worn to this condition in *two* weeks.



The $\frac{1}{16}$" bore Carbon Tetra Boride Nozzle with tapered lead-in was worn to this condition in *eight* weeks.



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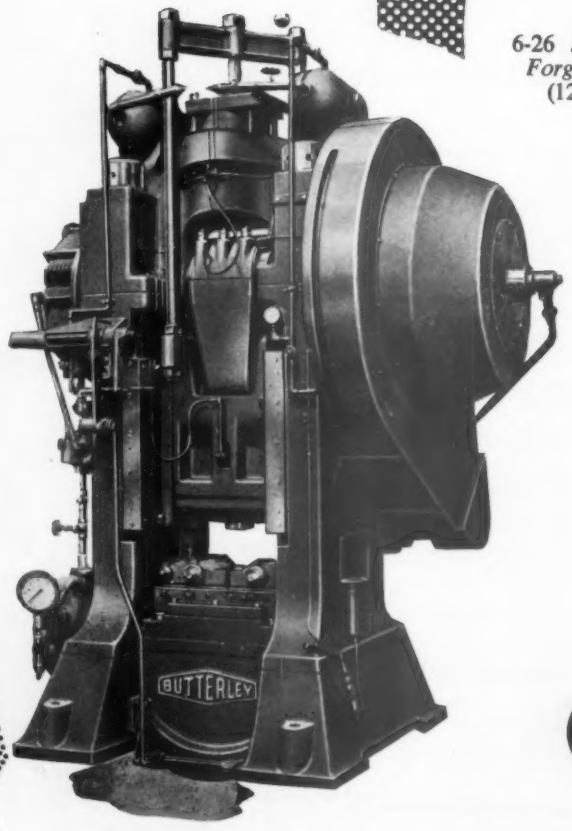


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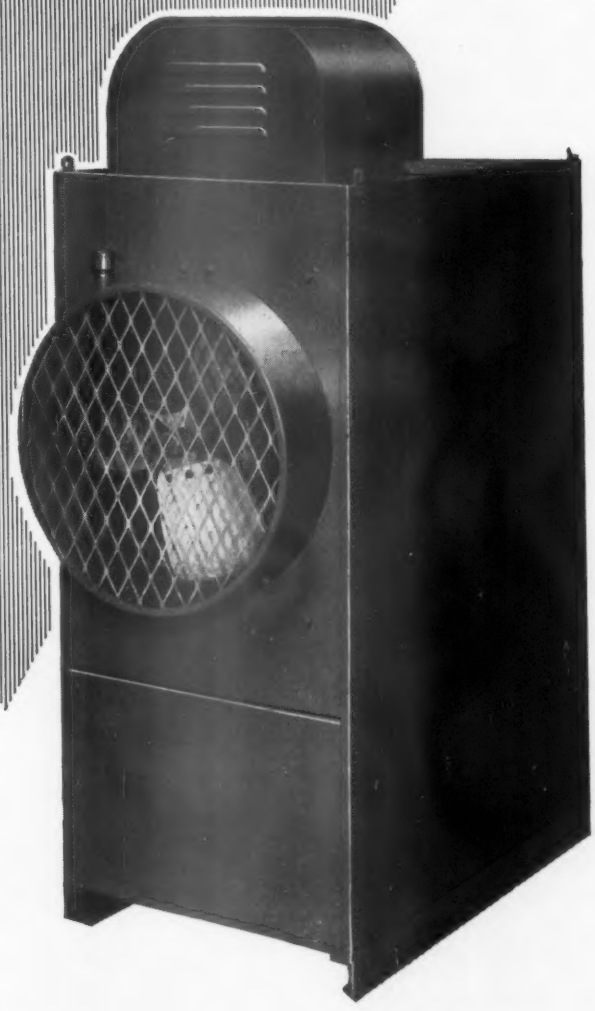

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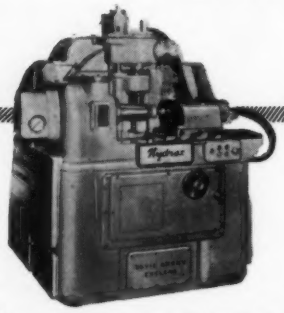

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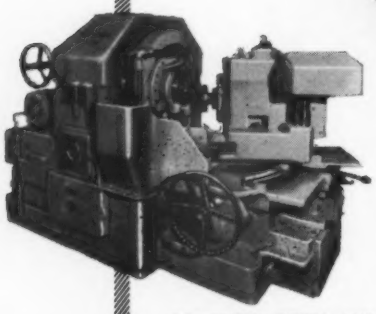

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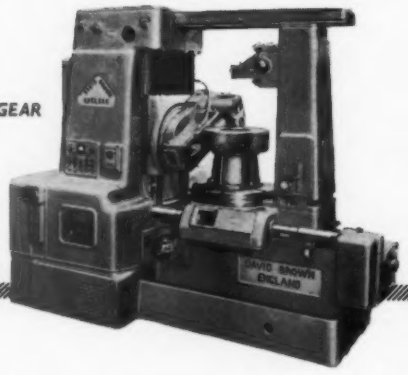

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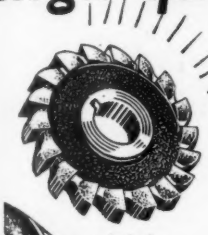
# B.S.A aids to Production

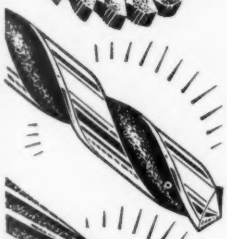
TRADE MARKS B.S.A

## *high quality tools for all classes of work*



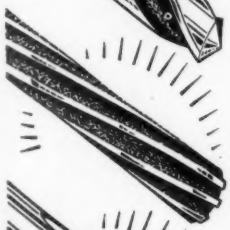
### MILLING CUTTERS

An extremely wide range. H.S.S. (and Cast, at lower cost). All the most generally used sizes and types. Super-cut, for heavy-duty milling, have specially designed teeth for extra strength. Form relieved and special cutters supplied.



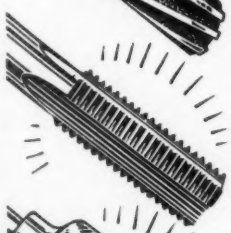
### TWIST DRILLS

Specially treated for long-life. Materials of only the highest grade are used in their manufacture. B.S.A. drills definitely reduce hole costs. H.S.S., Carbon steel, and special types for various materials.



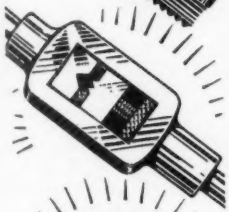
### REAMERS

All standard types and sizes available in H.S.S., including counterbores, adjustable reamers, shell reamers and arbors. Specialities include a Super-finish reamer for heat-treated steels, and a combined drill-reamer—a real time saver.



### TAPS

A complete coverage of standard H.S.S. ground thread, and carbon steel cut-thread and ground-thread. Sizes and types outside the usual range can be supplied, including taps with spiral points or spiral flutes, at special prices.

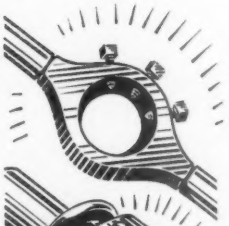


### TAP WRENCHES

These are of the adjustable type, Nos. 1 to 4, covering taps from $\frac{1}{16}$in. to 1$\frac{1}{4}$in. and Services type B.B.: $\frac{3}{16}$in. to 1in., C.C.: $\frac{1}{4}$in. to $\frac{3}{4}$in. Carefully treated, well finished, extremely durable.

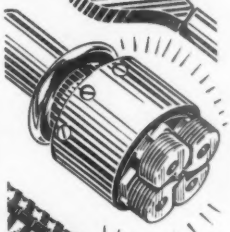
### SCREWING DIES

Carbon steel, circular adjustable type: plain, parallel and taper, for British and American threads and Metric sizes. Also a complete range of carbon steel hexagon die nuts. Of consistent quality and uniformity.



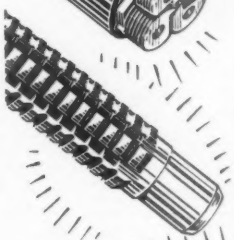
### DIE STOCKS

For circular dies from $\frac{13}{16}$in. to 2$\frac{1}{4}$in. dia. Made to the same high standards as other items in the B.S.A. range of screwing equipment. Also screwing sets, thread rolling dies, tap extractors and—



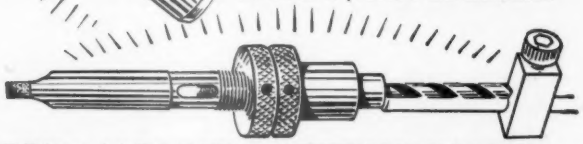
### DIEHEADS

B.S.A. NAMCO—simple in construction, easy to adjust. Circular chasers ensure extreme accuracy of thread form and long life. They can be ground and re-ground through a full 270 degrees of their circumference.



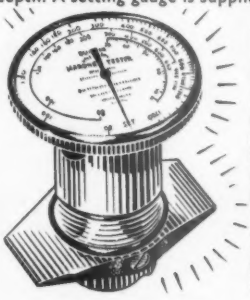
### BROACHES

Scientifically processed for extra performance. B.S.A. Tools' Broach Division has the capacity and ability for designing and manufacturing every size and type of broach, each to the highest standards of precision and endurance.



### DRILL HOLDER & SETTING GAUGE

For accurate drilling to pre-set depths. Safe and simple to use. Accommodates any size of drill, reamer or tool with a standard M.T. shank. The distance between the drill point and the lower face of the bush (which is screwed along the body then locked in position) establishes the required depth. A setting gauge is supplied to facilitate quick and accurate setting.



### PORTABLE HARDNESS TESTER

A lightweight, accurate, universal, direct-reading hardness tester. V.P.N., Brinell and Rockwell 'C' hardness values (B.S.I. 860) are marked in contrasting colours on its large easily-read dial. Pressure on the grip lowers the diamond indentor to the test piece. Further pressure causes the hardness value to be registered. Penetration in soft metal is only 0.005in. Supplied in a handsome case complete with servicing kit.

ALSO SCREWING SETS · DRILL CHUCKS · MACHINE VICES · MILLING MACHINE ARBORS · OIL & SUDS PUMPS · LIMIT SWITCHES

## B.S.A. TOOLS LTD., BIRMINGHAM, ENGLAND

*Sole Agents Great Britain:*

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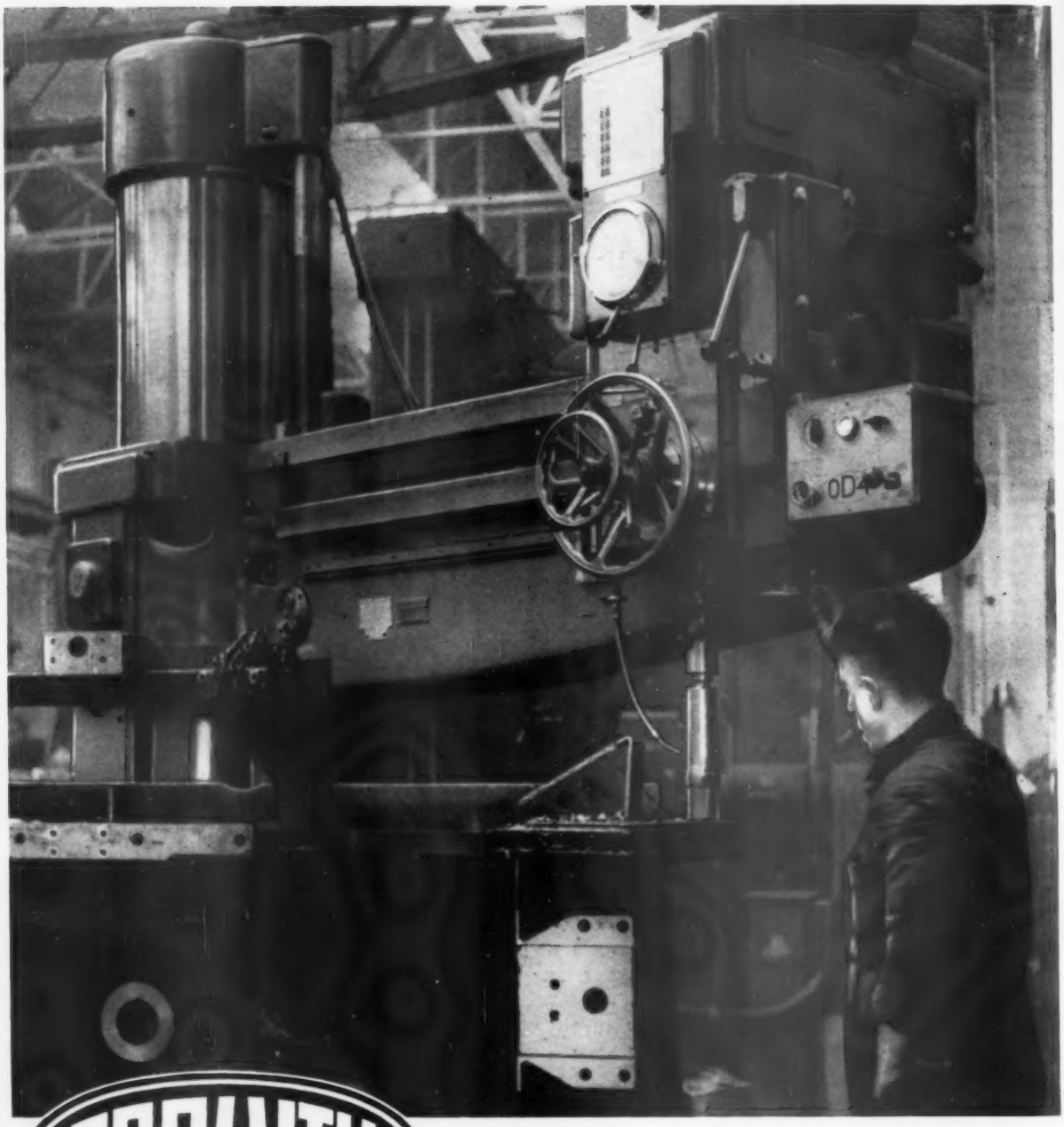
***Small Tools Division:*** Montgomery Street, Birmingham, 11. Tel: VICTORIA 2351 (9 lines)

BURTON GRIFFITHS



ASQUITH

**O.D.4.** *a heavy duty radial for the up-to-date Machine Shop*

This Asquith O.D.4. Radial Drilling Machine is employed for drilling, reaming, tapping and spot-facing operations on mechanical excavator revolving frames at Ruston Bucyrus Ltd., Lincoln. It is engaged on a regular production programme of 12 frames a week.

Write today for full details and mention the radius and drilling capacity which interests you.

**WILLIAM ASQUITH LTD.**

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A143

# The NEW MAXIMAJOR

## HEAVY DUTY, AUTOMATIC MULTI-TOOL LATHE

### SPECIFICATION

| | |
|---|---|
| Centre height from bed | 15 in. |
| Max. between centres | 78 in. or 102 in. |
| Max. swing over bed | 30¼ in. |
| Max. swing over slides | 21¼ in. |
| Max. saddle traverse | 20 in. |
| Mandrel speeds with A.C. motor | 5 to 50 up to 30 to 300 r.p.m. |
| Mandrel speeds with D.C. motor | 5 to 150 up to 10 to 300 r.p.m. |
| Main motor | 30 h.p. D.C. variable speed or 60 h.p. A.C. constant speed |

An additional range of equipment can be supplied if specified when ordering the machine, it includes:-
Central Driving Head for operating on both ends of component simultaneously.
Double End Drive as illustrated opposite, for use on off-centre work or where central steady cannot be used.
Second Saddle to accommodate additional cross slides, operating in same or opposite direction to first saddle.

The "Maximajor" meets the need for heavy automatic multi-tool turning of components beyond the capacity of the highly successful "Maximatic" Lathe.

It operates on a fully automatic cycle under the control of a single lever; front and rear slides are independently controlled and setting is easily and quickly accomplished. Every feature of design is calculated to provide a continuous high performance under really heavy cutting.

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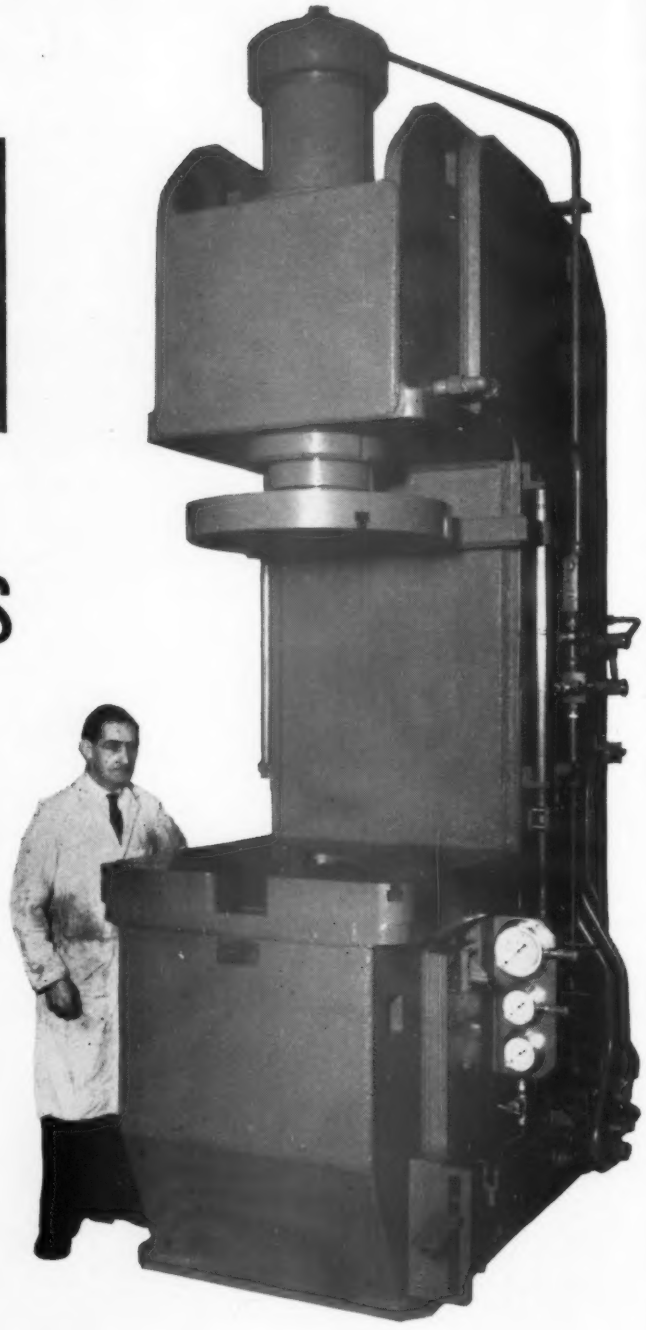
# HI-TON

## The modern
# HYDRAULIC PRESS



Hi-Ton Hydraulic Presses are made in a range with maximum ram pressures from 0.7 tons up to 300 tons. The machine illustrated is a 150 ton open throat drawing press.

Pressure of all Hi-Ton Presses is variable from zero to the maximum of the press. No excess pressure need therefore be applied to any work, and consequently long tool life is assured.

Hi-Ton Hydraulic Presses are being employed for a variety of operations such as drawing, straightening, blanking, assembling, etc., and are showing to advantage in terms of increased output and lower manufacturing costs.

Write today and ask for further information, mentioning the type of application which interests you.

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# A NEW

SWIFT

## 'T' LATHE for hydraulic copy forming

The maximum diameter admitted is 20" and the headstock has 12 spindle speeds from 14 to 500 r.p.m. In addition, a constant cutting arrangement gradually speeds up the spindle as the tool approaches the centre.

The driving motor is reversible so that the tool can cut at either front or rear of centre and quick power traverse can be applied to the surfacing motion so that the tool can rapidly traverse from front to back or vice versa.

**GEORGE SWIFT & SONS LTD.**

**HALIFAX · ENGLAND**

*Write today for full details*

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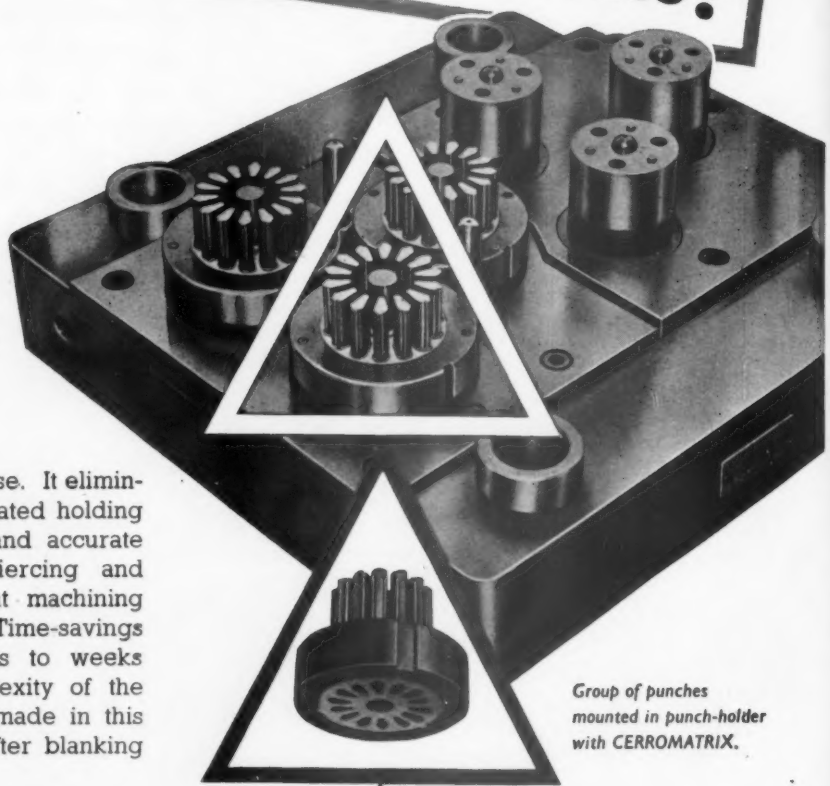
S141

# Does YOUR Toolmaker use CERROMATRIX

## and save 90% OF COSTS?

**135 HOURS**
*cut to* **13 HOURS**

*By orthodox methods, it took 135 hours to turn and mill the punch holder, and fit the punches in this tool shown by courtesy of Joseph Lucas Limited. Using Cerromatrix the time was cut to 13 hours.*



Cerromatrix is simple to use. It eliminates the need for complicated holding devices. It allows fast and accurate location of blanking, piercing and trimming punches without machining non-working surfaces. Time-savings range from a few hours to weeks depending on the complexity of the required die; and tools made in this manner are still in use after blanking over a million pieces!



*Group of punches mounted in punch-holder with CERROMATRIX.*

# CERROMATRIX

***LOW TEMPERATURE-MELTING EXPANDING ALLOY***

*Section through punch-holder assembly showing simple "anchorages" between CERROMATRIX and holder-ring, and CERROMATRIX and punches.*

*Write for* **CERROMATRIX** *manual today!*

**MINING & CHEMICAL PRODUCTS LTD · 86 STRAND LONDON WC2 · Telephone TEMPLE BAR 6511**

NEWALL-KEIGHLEY

# 'L' TYPE CYLINDRICAL GRINDER

A PRODUCT OF:
KEIGHLEY GRINDERS (M.T.) LIMITED · KEIGHLEY · YORKS

As modern as the moment and unexcelled for fast, accurate production, the Newall-Keighley 'L' Type Cylindrical grinder is employed for production grinding of high-precision components by **S. SMITH & SONS (ENGLAND) LTD.**

An exceptionally sturdy machine, the 'L' Type grinder is available in four sizes: 12" x 24" to 12" x 60" and although primarily a plain grinder, a wide range of equipment provides facilities for grinding convex and concave radii, angle and shoulder work, special form and centre grinding.

Illustrated brochure and full details supplied on request to:

## NEWALL GROUP SALES LIMITED

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ONE OF THE NEWALL GROUP

# Tough heads for safety

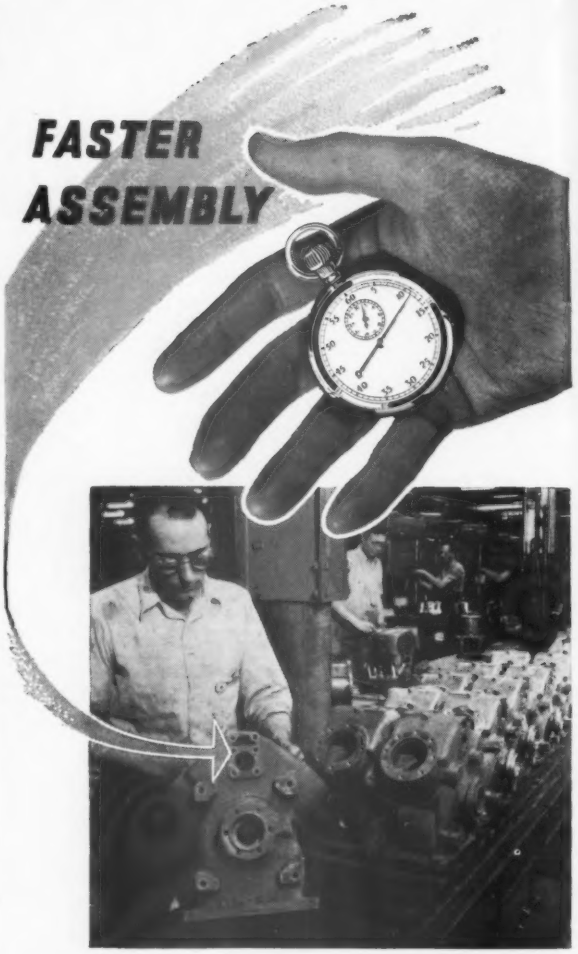
Bedford Chisels cut deep and quickly. There's a cutting edge that is hard wearing and hard biting but for greater safety the head is not hardened. Take care to dress the heads regularly on a grinding wheel.

*if it's a good chisel it's a*

# BEDFORD

**JOHN BEDFORD & SONS LTD LION WORKS SHEFFIELD**

718




WITH...

# HELI-COIL★

## SCREW THREAD INSERTS

★ *Regd. Trade Mark*

No fractional gains either; substantially faster and surer assembly is a certainty and here's why—

**Fit Heli-Coil!** and reduce number of fastenings required. Use set bolts (which can now be shorter) instead of double threaded studs and eliminate "worrying" cover plates etc., into position.

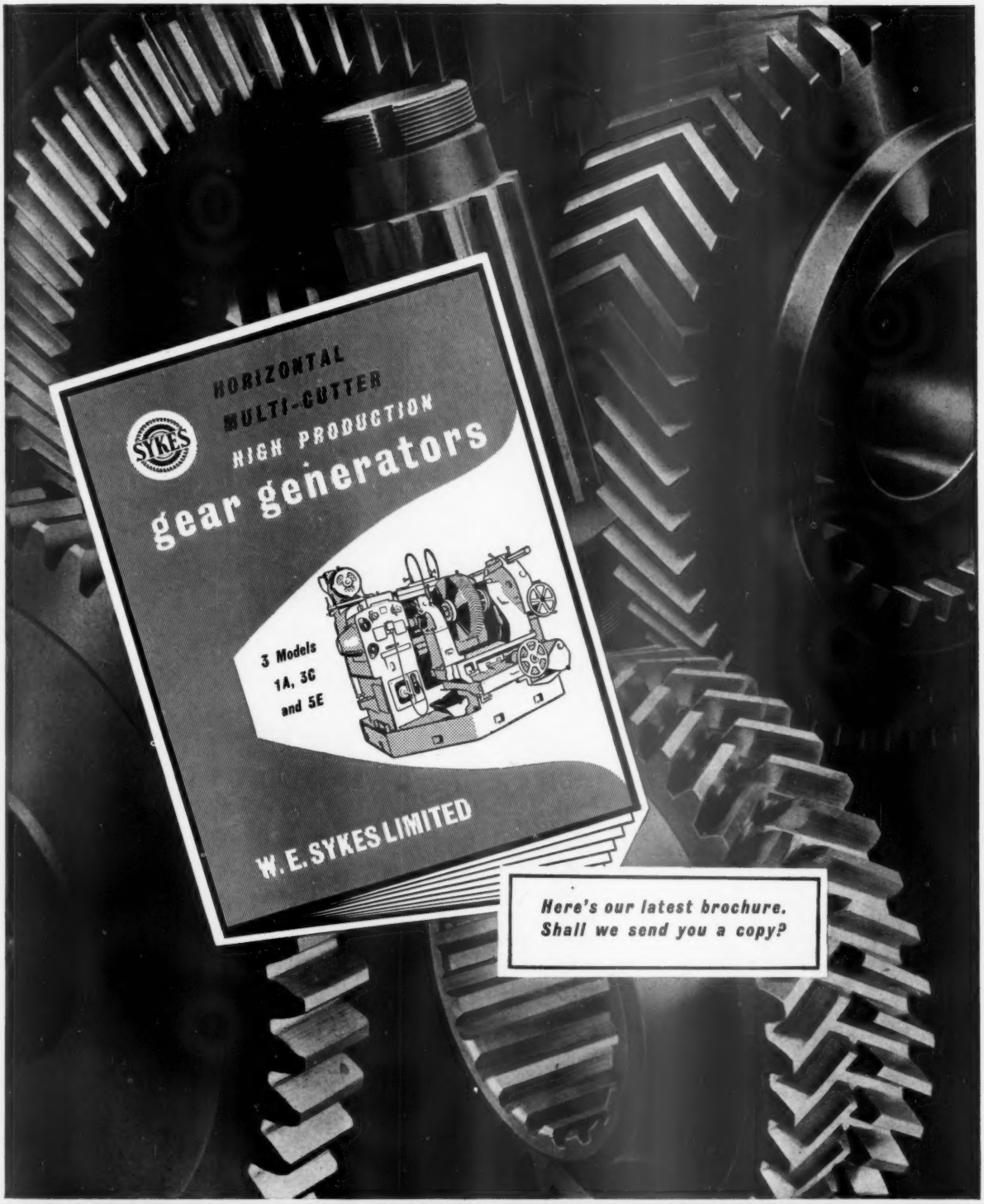
**Fit Heli-Coil!** and reduce torque loading for same duty. Reduce the wall boss size—no counterbore needed. Use lighter materials and improve thread strength.

**Fit Heli-Coil!** and have all the advantages of a polished, rolled, internal thread.

*Please write for full information.*

**ARMSTRONG PATENTS CO. LTD.**

**BEVERLEY · YORKSHIRE**




**W. E. SYKES LTD.** STAINES · MIDDLESEX · ENGLAND

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CANADA: Sykes Tool Corporation Ltd., 123-131, York St., Toronto.

AUSTRALIA: W. E. Sykes Ltd., Mascot, Sydney, N.S.W.

# REDUCING VALVES for $CO_2$

Simple, reliable, and comparatively inexpensive, the Blakeborough Class A2 Diaphragm Type Reducing Valve is giving excellent service on foundry $CO_2$ process lines, where it provides efficient means of breaking down the pressure to local distribution points. The valve has a bronze body and is supplied in a range of sizes from ¼" to 1" bore, with screwed connections. The maximum pressure rating and range of reductions available amply cover all regular requirements.

BLAKEBOROUGH

J. BLAKEBOROUGH & SONS LTD., BRIGHOUSE, ENGLAND

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# POWER APPLICATION

## at its best

### HYDRAULIC POWER PRESS

- *Occupies only 3 sq. ft.*
- *Weighs only 10 cwt.*
- *Develops up to 12 tons pressure*
- *Compact and Sturdy Build*
- *Operators hands free at all times*
- *Extreme sensitivity of Ram Control*
- *Foot Control*

RELIABILITY AND SERVICE

### HYDRAULIC CROPPING MACHINE

- *Weighs only 5 cwt.*
- *Up to 17 tons pressure on the Shear Blade*
- *Fully Automatic Operation and Foot Control*
- *Cutting speed up to 34 cuts per minute*
- *Grip on metal to be cut up to 1½ tons*
- *Mild steel bar up to 4" x ½" cut at one stroke*
- *Negligible burr on cut metal*

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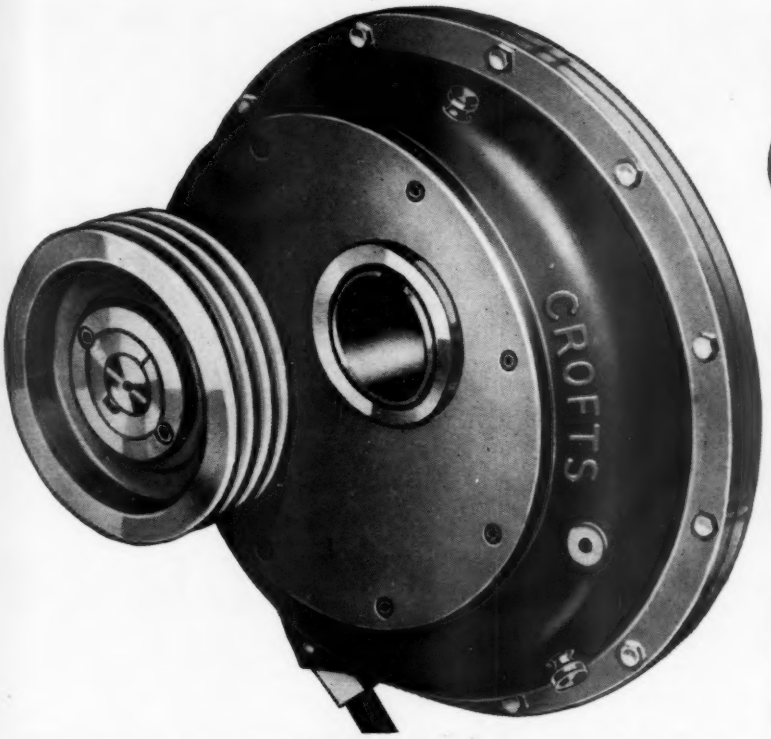



Crofts

# SHAFT MOUNTED GEAR UNITS

***A development of our live shaft floating drive which has proved highly successful for over ten years***

**8 SIZES** of SINGLE REDUCTION GEARS — powers up to 110 h.p. output speeds from 110 to 425 r.p.m. when used with Crofts Supror Sure-Grip V-Rope drives.

**8 SIZES** of DOUBLE REDUCTION GEARS — powers up to 70 h.p. output speeds from 8 to 125 r.p.m. when used with Crofts Supror Sure-Grip V-Rope drives.

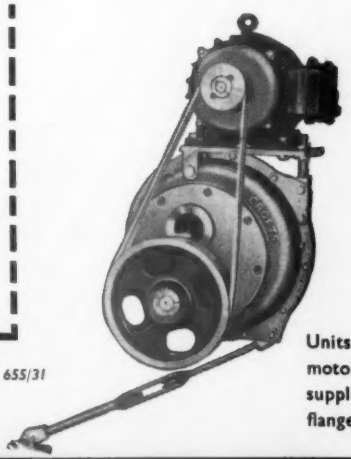
Used in combination with other standard Crofts products, a much wider range of torques and speeds (including infinite variation) is possible.

SIMPLE MOUNTING direct on to the machine shaft, whatever the angle, eliminates couplings, baseplates and foundations. This makes an ideal drive for vertical or inclined agitator shafts in chemical and food processing machinery, as well as for any horizontal application.

INTERCHANGEABLE BUSHES facilitate fitting on a wide range of shaft diameters.

DIFFERENT SPEEDS easily obtained using quick-change Crofts Taper-Flushbush pulleys.

BELT TENSION simply adjusted by the torque reaction bar.



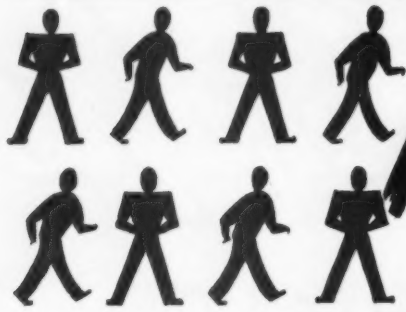
Units can carry driving motor as shown, or be supplied fitted with flange mounting motor.

*WRITE FOR PUBLICATION NO. 655/31*

Crofts (ENGINEERS) LIMITED. BRADFORD 3. ENGLAND

177.

PHONE :- 65251 (15 LINES) GRAMS :- "CROFTERS BRADFORD"



# MAN POWER

Time on the job enters into every stage of industrial production. Arrivals and departures, time on the bench or machine, breaks for meals and overtime are all related to cost of production.

GLEDHILL-BROOK Time Recorders provide the most adaptable means of recording regular or irregular hours on the job, automatically and accurately, every minute of every hour day and night.

Available with either 8-day mechanical clock movement or electrical operation.

# IS TIME POWER

*Write for full information and illustrated leaflet to:—*

**GLEDHILL - BROOK TIME RECORDERS LIMITED**

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# It must be...

Durachrome treatment gives a surface of exceptional hardness (910/930 Vickers Diamond) which resists abrasion and corrosion. Cylinders, shafts, rams and all heavy duty components have a greatly increased life by Durachrome application of hard chromium. One part or production quantities can be treated.

Estimates and full particulars from

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HARD CHROMIUM SPECIALISTS

... it IS Durachrome!

(REGISTERED . TRADE MARK)

# Pneutomation

What is it ? . . . . . Pneutomation is an ability to speed production with less skilled labour; the capacity for arranging complex sequence machining automatically, with fine precision : it is the elimination of human error, the beginning of faster production times . . . . . it is Lang Pneumatic. Pneutomation is automatic control of machinery and production processes at its best — 'automation' (see other pages of this issue) with a skilled difference.

*All Lang Pneumatic Control Equipment is made of stainless steel, brass, copper and other non-corridible metals. Because of this it will withstand many years of hard work under arduous conditions. It is, in fact, the finest pneumatic control gear obtainable. It is used for Automatic Boring, Automatic Single and Sequence Machining Operations, Selection Processes, and many forms of specialised application in over 700 leading industrial concerns.*

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# PROMPT DELIVERIES — FROM STOCK

A genuine off the shelf service for all machine shop equipment is offered. Comprehensive stocks of "Galtona O.K." Serrated blade cutters; "Galtona" Ground thread taps and dies; twist drills; J & S Tools; Vices; H.S.S. Milling cutters and reamers; Carborundum products; lathe and drill chucks; socket head screws; precision tools; power transmission appliances; belting, pulleys and mill gearing; mill furnishing; machine tools and equipment:—

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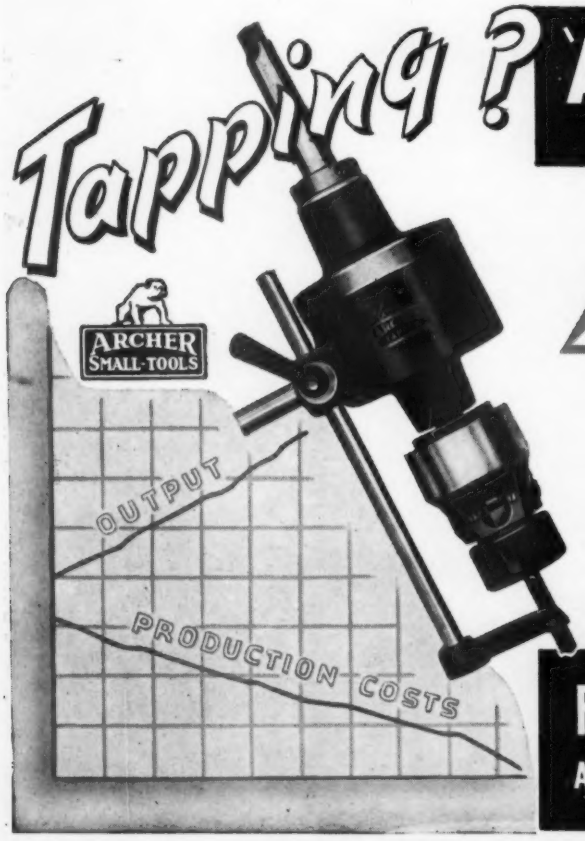
Tapping ?

'ARCHER' TAPPING ATTACHMENTS
WITH *AUTOMATIC* REVERSE




4 special features

- SIMPLE TO OPERATE
- TAKES STANDARD HAND TAPS
- FITTED WITH SAFETY FRICTION DRIVE
- HARDENED NICKEL CHROME STEEL GEARS

**'ARCHER' Tapping Chucks are also made as separate units for tapping operations where the auto-reverse is not required, and can be supplied with friction drive having the Morse Taper Shank integral with the friction box; or with positive drive having Jacobs No. 2 series taper bore.**

**Ask for List No. 105**

FRANK GUYLEE & SON LTD
ARCHER TOOL WORKS · MILLHOUSES · SHEFFIELD 8

Although designed primarily for the machining of light alloys, a wide range of speeds and feeds gives the ARCHDALE 18" VERTICAL remarkable scope on many other materials. A typical example of this versatility is seen at the Birmingham works of Stampings Alliance Ltd., where it is applied to good effect in sinking cavities in chrome—nickel—molybdenum die steel. There are 18 spindle speeds ranging from 18 to 2,000 R.P.M. and 4 rates of longitudinal table feed for each speed. The spindle has rapid and fine vertical adjustment and the swivelling head machine gives up to 45° inclination each side of the vertical

ARCHDALE
18" VERTICAL MILLERS WITH FIXED OR SWIVEL HEAD..

JAMES ARCHDALE & CO. LTD., BIRMINGHAM 16
SOLE SELLING AGENTS: ALFRED HERBERT LTD., COVENTRY

# *Cheapest in the Long Run*

Fitted in minutes without dismantling machinery. Stocks of belting can be reduced by 90%. Five coils of " BRAMMER " will replace 295 standard sizes of solid endless ropes.

Tested, pre-stretched and matched belts available from stock.

Coloured studs identify " BRAMMER " 40° angle sizes.

The original and only rubber V-link belt which has been tested and proved for over 25 years.

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There are few restrictions upon the component-forms and arrangements of section that can be *cast* in steel. Thus, the steel casting process affords great scope to the Designer, and unrivalled production facilities to the Production Engineer.

The extent to which a steel casting can be made closely to conform to the final dimensions and contours of the finished component, cuts machining time to a minimum, thereby reducing the cost of the finished part.

A steel casting may be a massive **cast-in-one-piece** component (such as the casting illustrated above) or it may be a small part of a structure introduced to impart strength and rigidity at some vital point. Alternatively, a structure may be built up by assembling a number of steel castings conjoined by welding or bolting.

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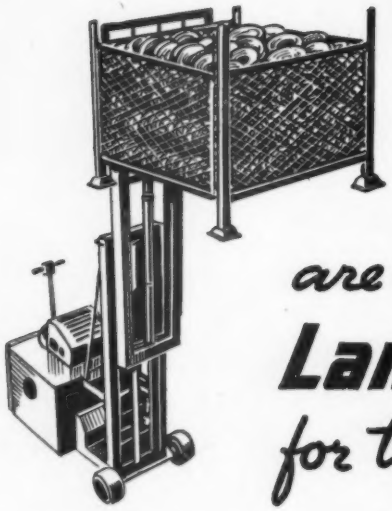
STEEL CASTINGS



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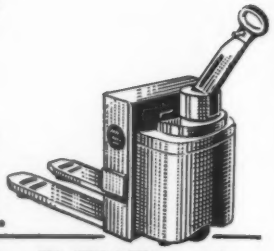

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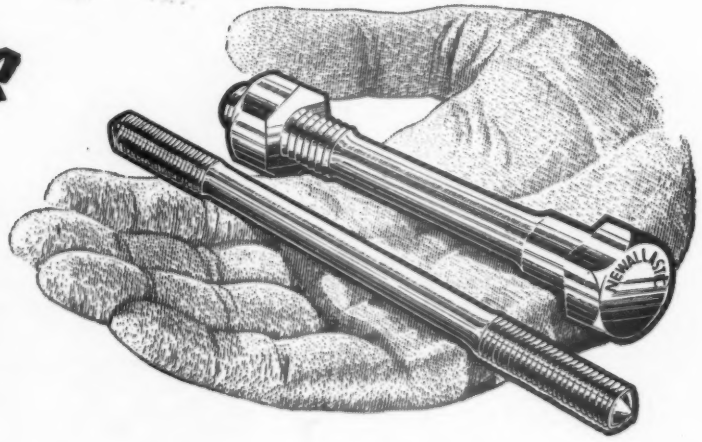
"Newallastic" bolts and studs have qualities which are absolutely unique. They have been tested by every known device, and have been proved to be stronger and more resistant to fatigue than bolts or studs made by the usual method

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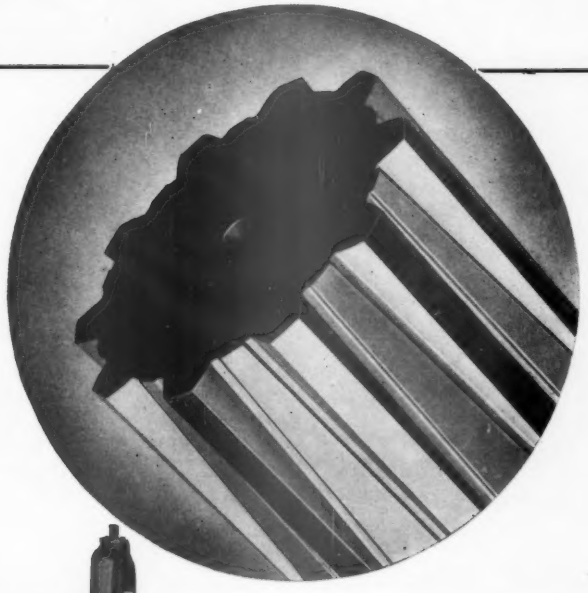
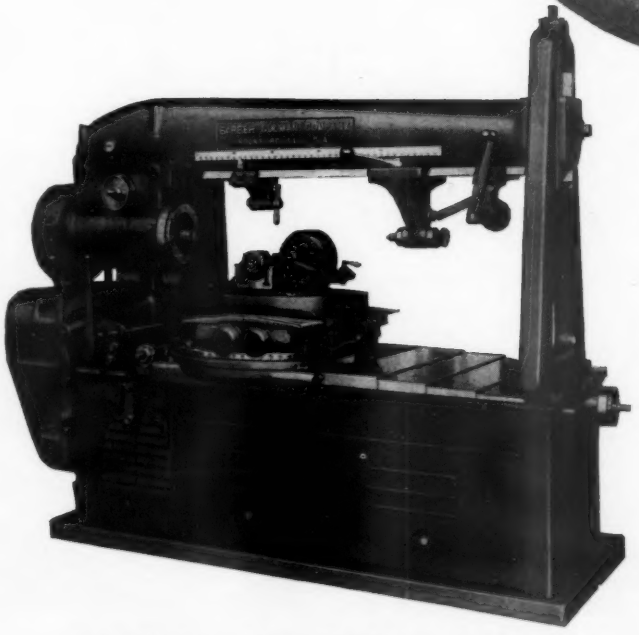
*another* **BARBER-COLMAN** *development*

# THE TAPER CORE SPLINE





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It is the ideal machine for the manufacturer who desires to improve his product by applying taper splines, eliminating the necessity of buying a special machine which could otherwise not be used for general work.

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- Provides greater area of key contact.
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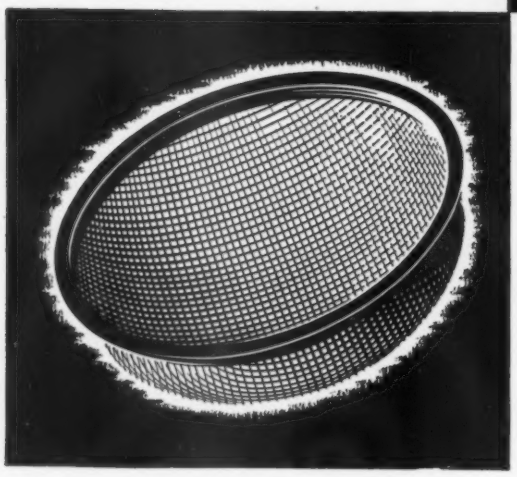

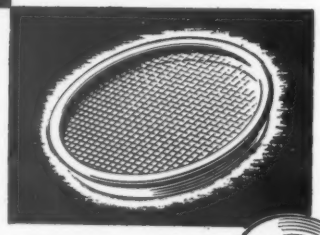

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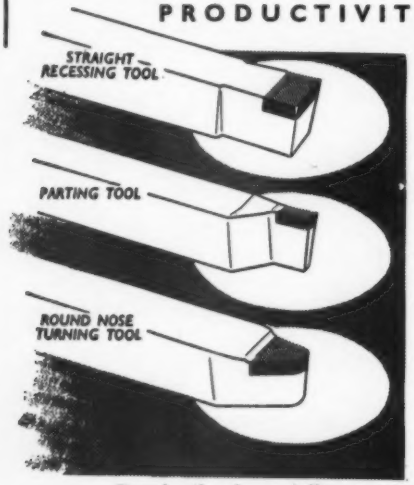


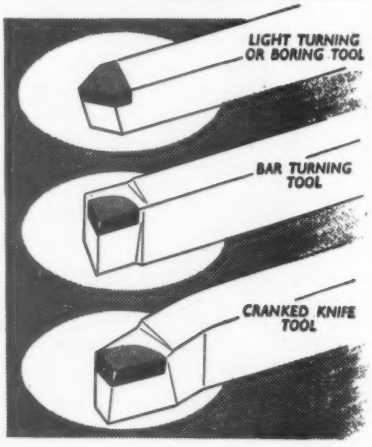


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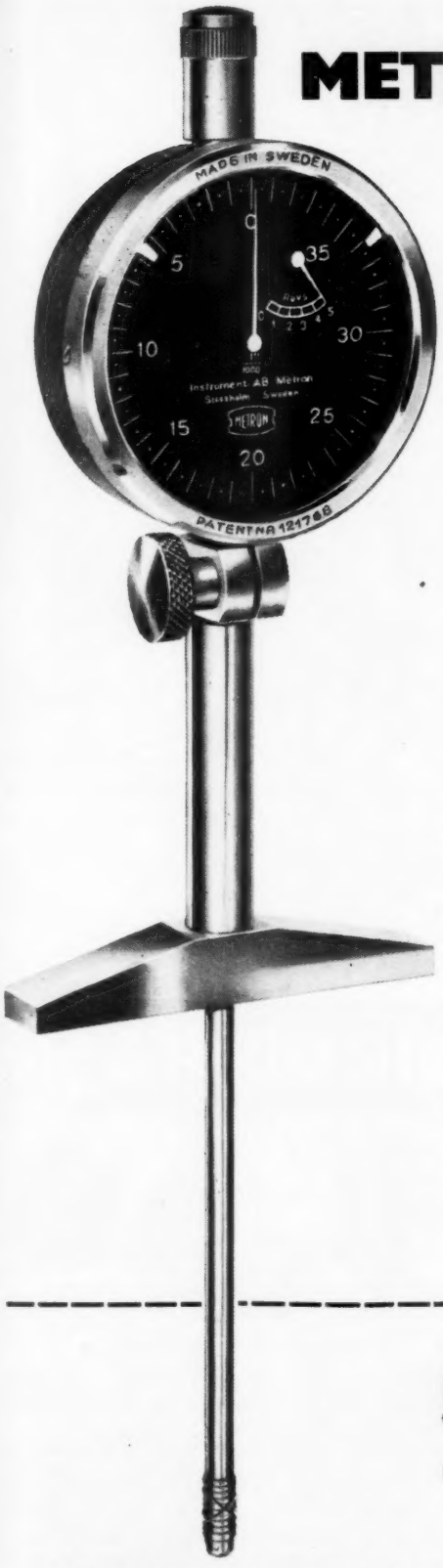


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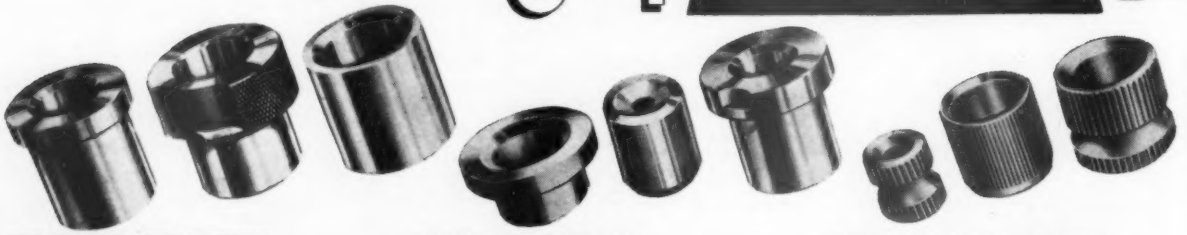

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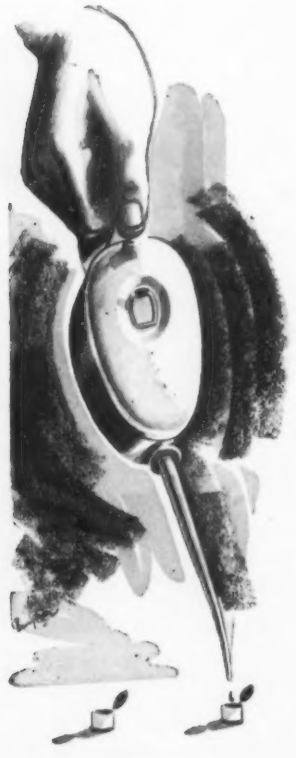

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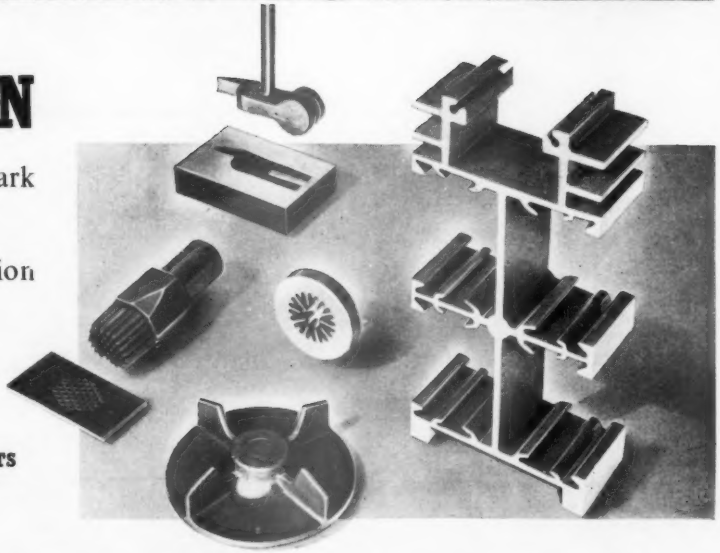

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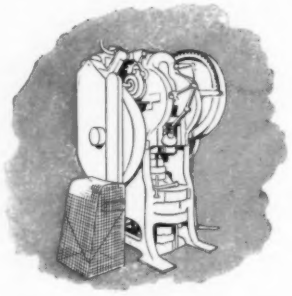

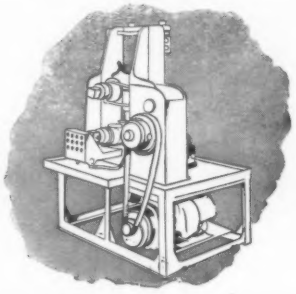

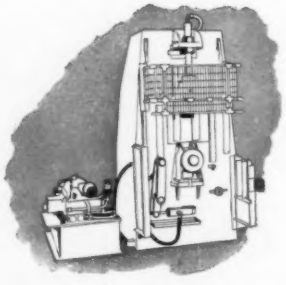

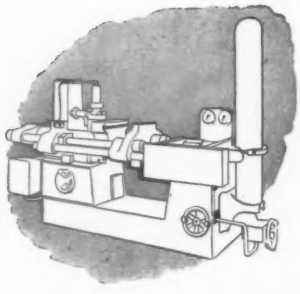

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(*One of the Sheepbridge Engineering Group*)

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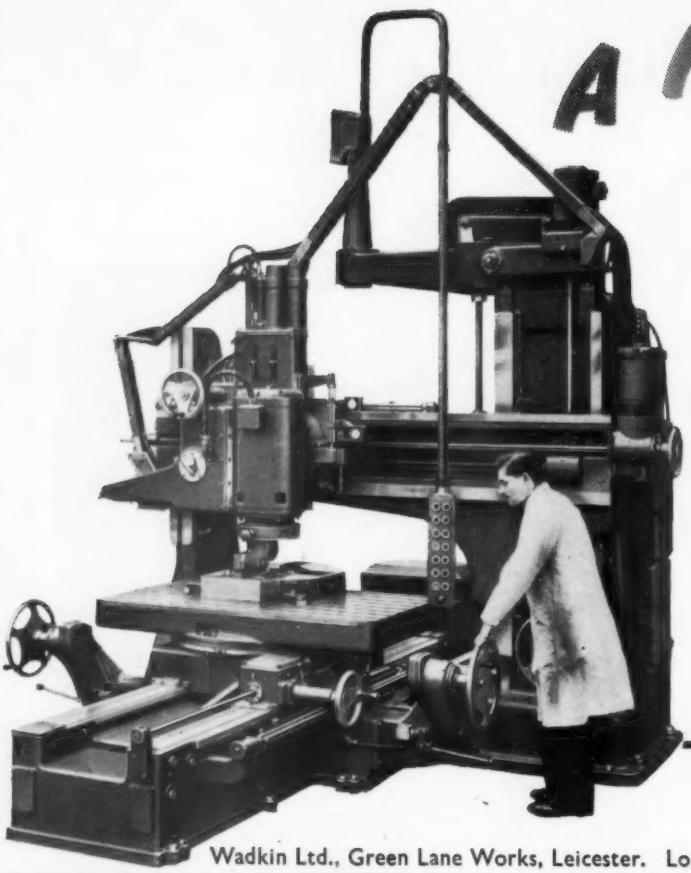

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*with speeds from 30-3000 r.p.m.*

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- Can be used for either left or right hand threads.
- Particularly suitable for the gauging of acme forms of thread.
- ★ Can be supplied for "GO" only, or "NOT GO" only, or both "GO" & "NOT GO" combined.

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★ **CAN BE SUPPLIED FOR "GO" ONLY, OR "NOT GO" ONLY, OR BOTH "GO" & "NOT GO" COMBINED.**

The standard gauge is supplied for both "GO" and "NOT GO" limits but models are available for those desiring "GO" only or "NOT GO" only.

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*This illustration shows an Arrow 30 amp Contactor* actual size.

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Coils and contacts changed in a matter of seconds.

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Conforms with American N.E.M.A. specification.

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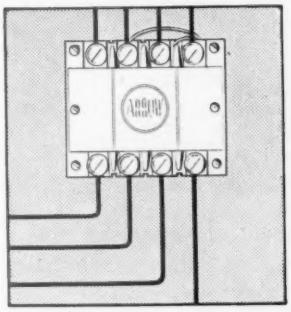
This is a completely new, built-in, advanced wiring design. Installation time is greatly reduced and circuit identification is easy and positive.



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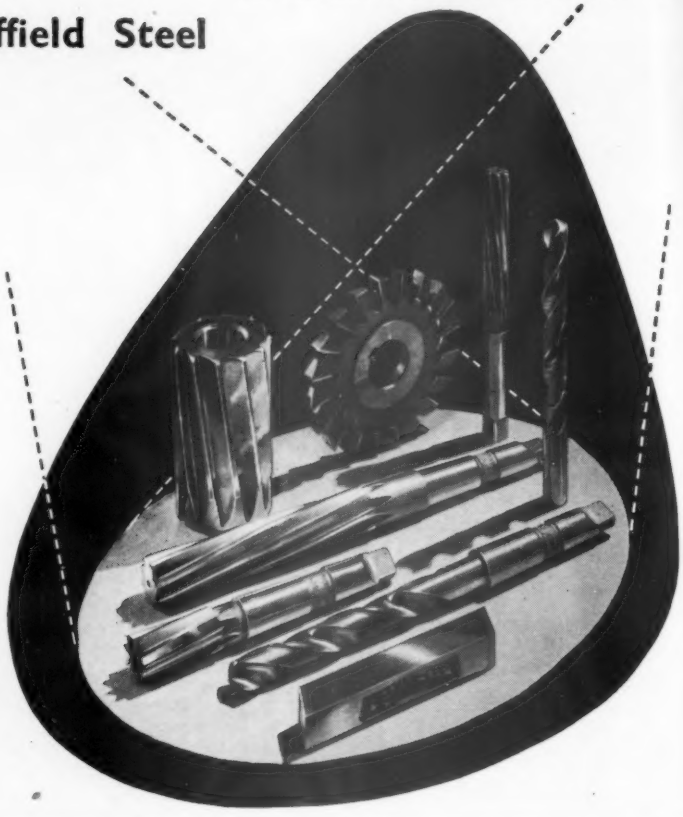

**MARSH BROTHERS**

of Sheffield England

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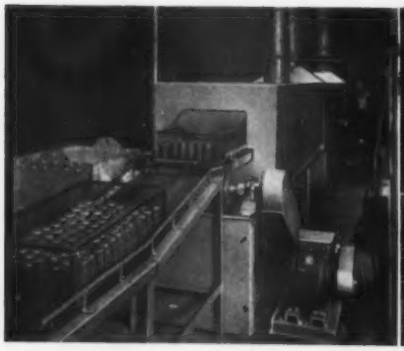
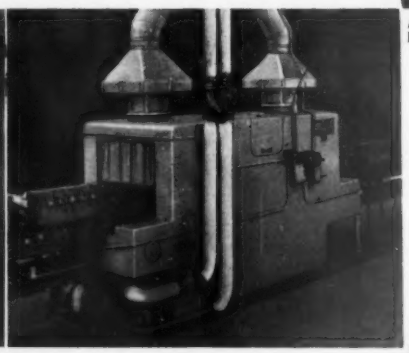
# The most practical plant for Cleaning METAL PARTS

**PRIOR TO ASSEMBLY, and BEFORE and AFTER REPAIRS**

A 'Junior' type machine supplied to a Midlands Motor Car Works.



Supplied for the washing and drying of Tractor parts. Crank Shafts, Sumps, Pressings, etc.

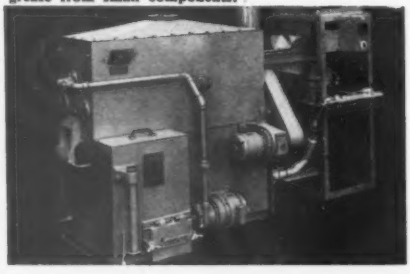


A model 'A' machine, washing parts of motor car engines prior to assembly.

## Dawson

**DE-GREASING AND CLEANING MACHINES**

A Rotary Drum machine for removing swarf and grease from small components.



Dawson Metal Parts cleaning machines are supplied for all branches of the engineering industry. Their chief characteristics are robustness of design, small number of working parts and simplicity of operation. Space only permits the illustration of four of the many types of machines built for quick economical washing and drying of Metal Parts.

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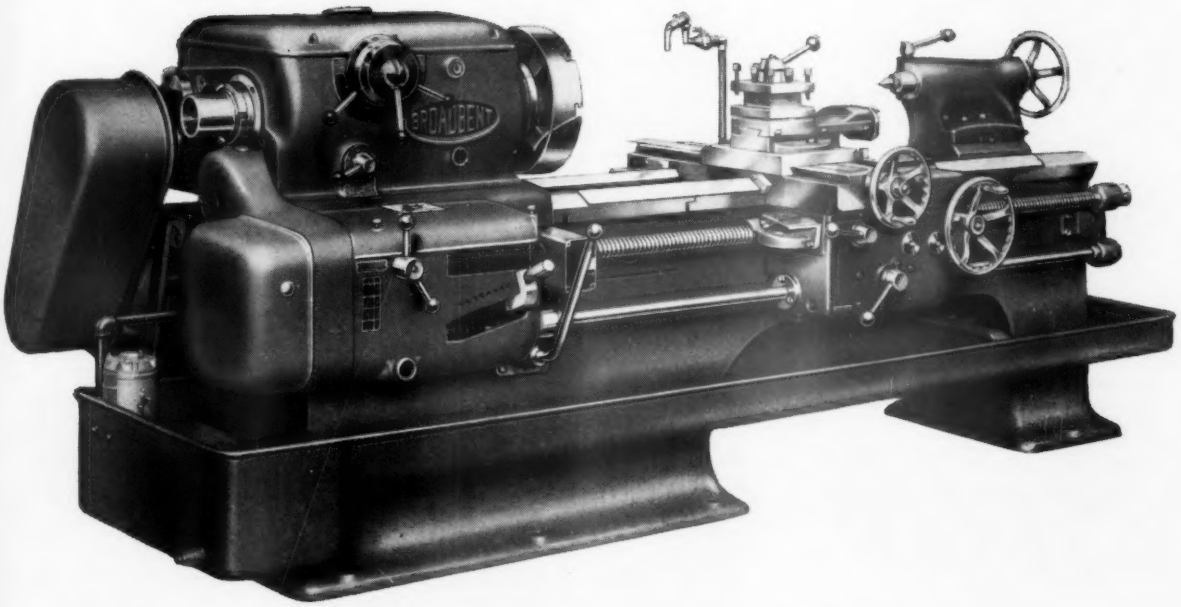
# BROADBENT *Lathes*




For more than 80 years the name of BROADBENT has been synonymous with high quality centre lathes. The accumulated knowledge and experience of lathe manufacture gained during that time is reflected in the design and performance of present-day machines.

In addition to standard Centre Lathes from 8¼" to 24" height of centres, we also specialise in Surfacing and Boring Lathes, Break Lathes, Heavy Duty Horizontal Plano-Milling Machines and Vertical Boring and Turning Mills.

Please write for descriptive literature illustrating the full range of Broadbent Machines.

BROADBENT

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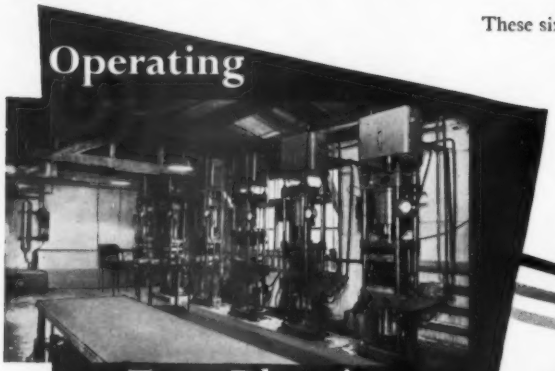
BL3

# ONE Greer-Mercier accumulator
# a 3 G.P.M. pump
# a 4 H.P. motor




These six 50-ton downstroking Finney presses — part of a plastics production plant — operate on a two minute cycle at speeds up to 3″ per second.

The power unit consists of a Finney single stage 4 H.P. relaying pump of 3 g.p.m. capacity at 3,000 p.s.i. working in conjunction with one 8 gallon nominal size GREER-MERCIER HYDRO-PNEUMATIC ACCUMULATOR.

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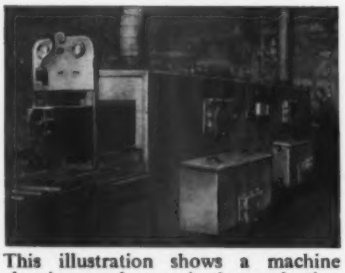

This illustration shows a machine cleaning crank cases in the production line. It is equally capable of cleaning small parts in baskets.

A power driven conveyor system is employed with this cleaning machine for ball bearings.

Trays carrying the work are pushed through on a roller conveyor by hand in this cleaning installation.

Whilst offering a very wide variety of standard cleaning equipment, it is BRATBY policy, wherever possible to design the machine to meet the particular cleaning problem. Careful study of each individual problem ensures maximum efficiency and economy of the plant in operation. The illustrations show but a few of the specific types of Cleaning Machines designed by BRATBY for individual needs.

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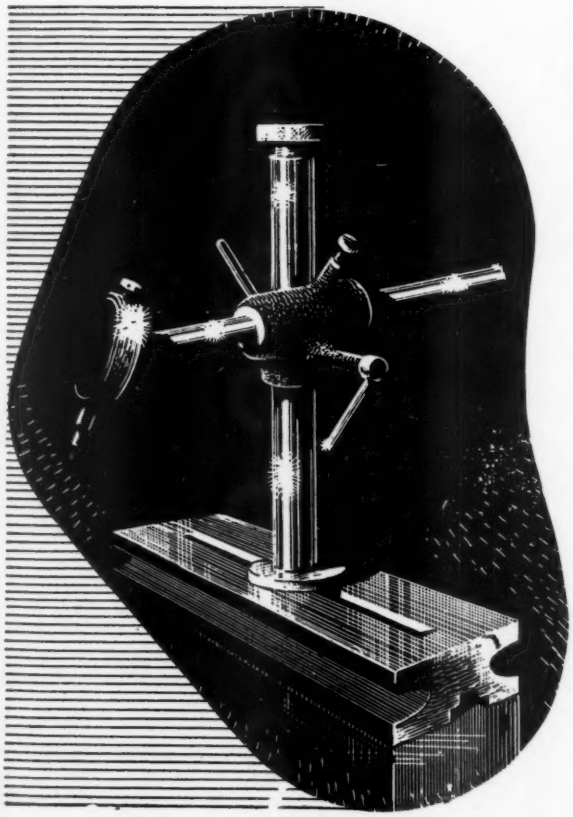

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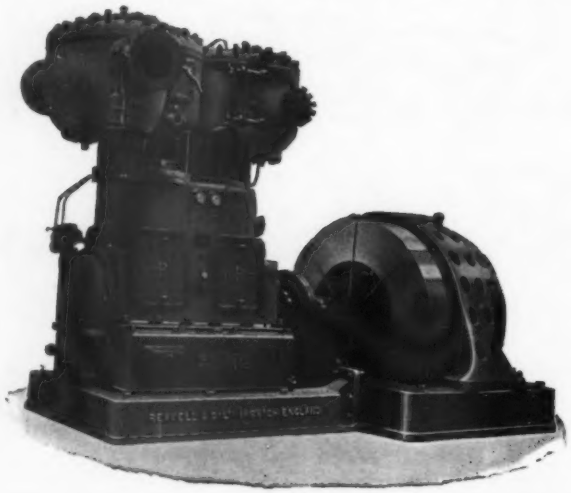

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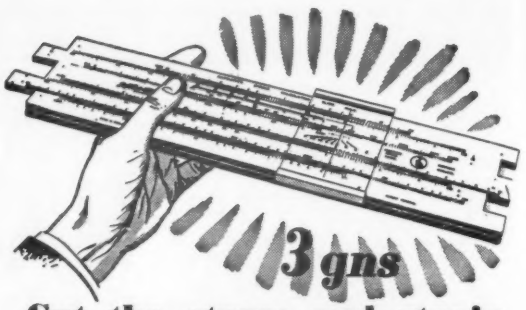


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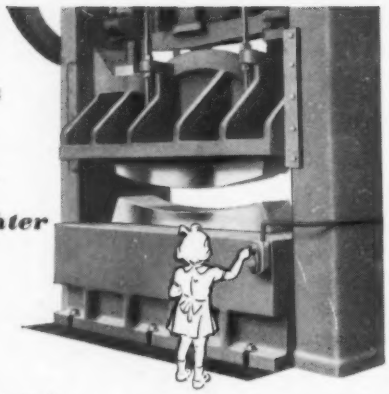

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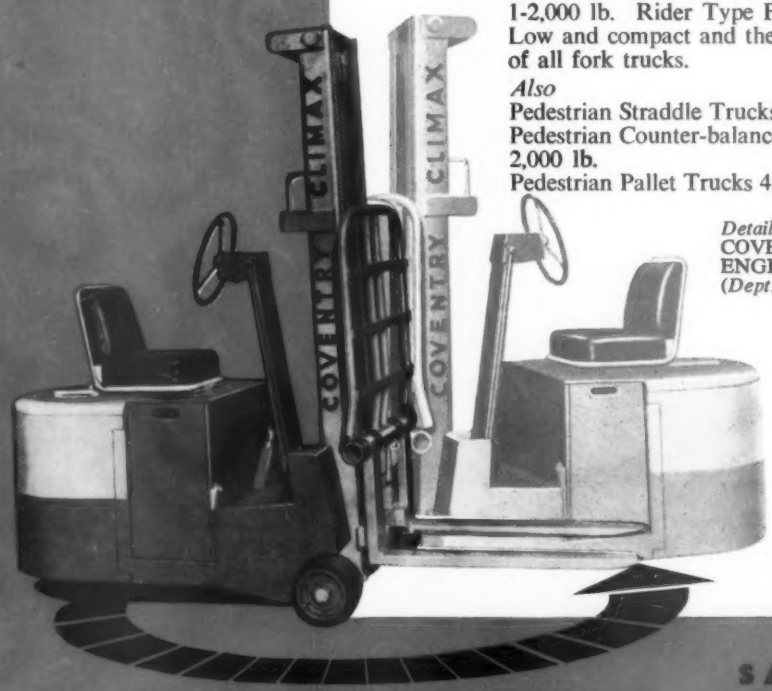


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